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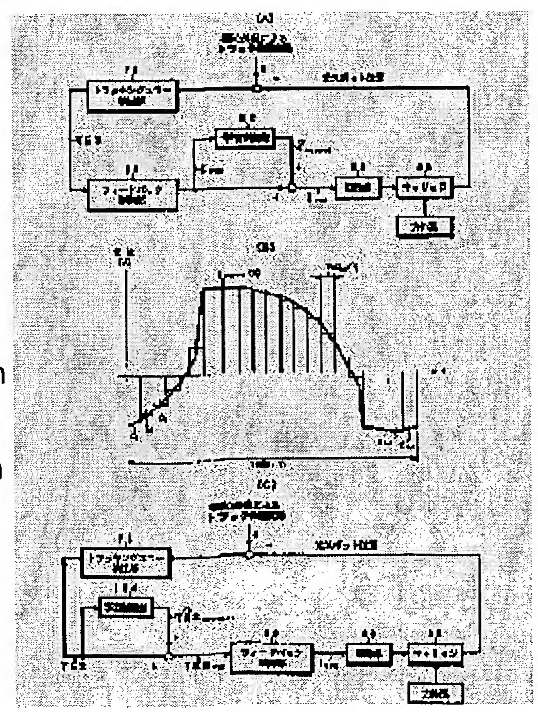

(57)Abstract:

PROBLEM TO BE SOLVED: To make follow-up error with respect to the eccentricity of a medium smaller by combining a feedback control system and a learning system to compensate stepwise frictional disturbance.

SOLUTION: A learning control system 82 is provided between a feedback-arithmetic part 80 and a driving part 86 and when a time equivalent to one round of revolution of a medium is deffined as TL, it obtains an unknown driving current function Irepeat (t) which is repeated from the starting time t=0 of the one revolution of the medium to a completing time t=TL as an approximation function I repeat (t) which is made to be approximately estimated with heights of strips of respective sections which are obtained by dividing the time TL into N and which have section numbers i=0 to (N-1) by a learning algorithm and it performs a feedforward control by

outputting a learning signal I repeat in synchronization with the revolution of the medium after the learning. Moreover, the learning control part 82 may be provided between a positional signal detecting part 76 and the feedback arithmetic part 80 to learn a positional function TES repeat (t) as the similar approximation function TES repeat (t).

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CLAIMS

[Claim(s)]
[Claim 1] The position signal detecting element which detects and outputs the position signal according to the amount of location gaps of the location where the head which moves to the truck location of the arbitration of a medium, and said head on the basis of the predetermined location of the truck on a medium were positioned, The feedback operation part which calculates the control signal which moves said head so that said position signal may be inputted and said amount of location gaps may be oppressed to zero, With the actuator which drives said head so that said truck may be made to follow based on the control signal of said feedback operation part Storage characterized by preparing the learning-control section which gains the strange function for medium revolution 1 round for making the amount of location gaps to periodicity disturbance into zero with learning algorithm as an approximation function which carried out approximation presumption, and memorizes it in preparation **********.
[Claim 2] It is height C0-CN-1 to each section 0- (N-1) to which said learning-control section carried out N division of the time amount for medium revolution 1 round for said strange function in storage according to claim 1 of a strip of paper. Storage characterized by what it gains with learning algorithm as an approximation function which carried out approximation presumption, and is memorized.
[Claim 3] In storage according to claim 2 said learning-control section It is prepared among said feedback operation part and actuators, and is tangent line about the time amount for medium revolution 1 round. When it carries out, The start time t= 0 of medium 1 revolution to end time t=tangent line The strange actuation current function Irepeat to repeat (t) (However, the time amount which medium 1 revolution takes 0 <=t<tangent line and tangent line) Each section with section number i=0- (N-1) which carried out N division of the time amount tangent line for medium revolution 1 round (however, the time amount width of face T of each section) Approximation function I^repeat which carried out approximation presumption in the height Ci (however i being a section number 0<=i<= (N-1)) of the strip of paper of T=tangent line/N (t) It is the storage characterized by what it gains with learning algorithm as (however, time amount which medium 1 revolution takes 0 <=t<tangent line and tangent line), and is memorized.
[Claim 4] In storage according to claim 3 said learning-control section The memory equipped with two or more storage cells which store the height Ci of the strip of paper of each section of said approximation function I^repeat (t), The sample section which samples the control signal IFB outputted from said feedback operation part, Based on the control signal IFB and the predetermined study gain Klearn which were sampled in said sample section, it is [Equation 1] about the height Ci of the strip of paper of each section of said approximation function I^repeat (t) stored in each storage cell of said memory.

$$\dot{C}i = \mathrm{Klearn} \cdot I_{FB}(t)$$

However, i is the number of the section determined by time amount t, and is 0<=i<= (N-1).
It is alike and the height Ci of the strip of paper of each section of said approximation function I^repeat (t) remembered to be the updated approximation function operation part which asks for more to said

storage cell synchronizing with the division period T of said medium revolution is read as a learning-control signal. It adds to a control signal IFB from said feedback operation part, and is a driving signal IVCM to said actuator. It has the feed forward output section to supply. At the time of study Storage characterized by controlling said memory, the sample section, approximation function operation part, and the feed forward output section synchronizing with said medium revolution.
[Claim 5] It is the control signal IFB and the predetermined study gain Klearn which said sample section sampled the control signal IFB the predetermined period Tsample shorter than said division period T, and sampled said approximation function operation part in said sample section for said every sample period Tsample in storage according to claim 4. About the height Ci of the strip of paper of each section of said approximation function I^repeat (t) which it was based and was stored in each storage cell of said memory, it is [Equation 2].

$$\dot{C}i = Klearn \cdot I_{FB}(t)$$

However, i is the number of the section determined by time amount t, and is 0<=i<= (N-1).
By being alike and updating in quest of a twist, said feed forward output section reads the height Ci of the strip of paper of each section of said approximation function I^repeat (t) memorized to said storage cell for said every sample period Tsample synchronizing with a medium revolution, adds to a control signal IFB from said feedback operation part, and it is a driving signal IVCM to said actuator. Storage characterize by supplying.
[Claim 6] It is approximation function I^repeat (t) which memorized said feed forward output section to each storage cell of said memory in storage according to claim 3. Storage characterized by reading and outputting the value over the time of day when only predetermined time amount delta tlead progressed.
[Claim 7] In storage according to claim 2 said learning-control section It is prepared between said position signal detecting elements and feedback operation part, and is tangent line about the time amount for medium revolution 1 round. When it carries out, The start time t= 0 of medium 1 revolution to end time t=tangent line The strange location function TESrepeat to repeat (t) It is the height Ci (however, i is a section number) of the strip of paper of each section with section number i=0- (N-1) which carried out N division of the time amount tangent line for medium revolution 1 round for (however, the time amount which medium 1 revolution takes 0 <=t<tangent line and tangent line). Storage characterized by what it gains with learning algorithm as approximation function TES^repeat (t) (however, time amount which medium 1 revolution takes 0 <=t<tangent line and tangent line) which carried out approximation presumption, and is memorized by 0 <=i<= (N-1).
[Claim 8] It is the storage which performs acquisition actuation of said approximation function according [on storage according to claim 1 and] to said learning algorithm only in the time amount of the specification [said learning-control section] in specific timing, and is characterized by for after study outputting said gained approximation function synchronizing with a medium revolution, and carrying out feedforward control.
[Claim 9] It is the storage characterized by performing feedforward control which only specific time amount performs acquisition actuation of said approximation function by said learning algorithm to the timing immediately after insertion of said medium [on storage according to claim 8 and as opposed to equipment in said learning-control section], outputs said gained approximation function synchronizing with a medium revolution at the time of the tracking control after study, and removes periodicity disturbance.
[Claim 10] It is the store characterized by performing feedforward control which outputs said approximation function which gained said learning-control section in the store according to claim 8 at the time of the track jump after study, and seeking control synchronizing with a medium revolution, and removes periodicity disturbance.
[Claim 11] It is the store which said learning-control section is two or more places of a disk radial location, performs acquisition actuation of the approximation function to each part, chooses the approximation function used according to the radial location at that time at the time of the feedforward after said study in a store according to claim 8 or 10 at the time of acquisition actuation of said

approximation function, and is characterized by to act as feedforward.
[Claim 12] It is the storage characterized by applying learning algorithm by making the approximation function data which has already existed into initial value when the approximation function with which said learning-control section was already gained about the approximation function acquisition actuation by two or more places in storage according to claim 11 in another part exists.
[Claim 13] It is the store characterized by to have the structure of a single-drive mold perform both tracking control which an objective lens is carried [tracking control] on the carriage which can move in the direction in which said head crosses the truck of a medium in a store according to claim 1 freely , enable focal free control , and makes a light beam follow a truck by migration of said carriage , and seeking control which moves a light beam to the truck location of arbitration .

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the storage which carries out feedforward control in quest of the control signal for oppressing a location gap of periodicity disturbance, such as medium eccentricity, especially by learning control about the storage which carries out feedback control of the migration location of carriage so that the amount of location gaps of the head to a truck center may be made into zero.
[0002]
[Description of the Prior Art] In the conventional optical disk unit, in order to raise the flattery engine performance to the medium truck of a light beam The carriage actuator for seeking control (it is also called the object for robust control, or the object for coarse controls) which moves the carriage supported in the plain-bearing section to the guide rail placed in a fixed position, The head device of the twin drive mold which consists of truck actuators for tracking control (it is also called energy control or the object for fine control) made to move a light beam in the direction which crosses a truck by actuation of the objective lens carried on carriage is adopted.
[0003] However, recently, the head device of the single-drive mold which abolished the truck actuator and was used only as the carriage actuator for the cost cut of equipment has also spread widely. Moreover, by the head device of a single-drive mold, a ball bearing is deleted and reduction and a conte down of components mark are in drawing.
[0004]
[Problem(s) to be Solved by the Invention] However, when a head device is used as the single-drive mold of only a carriage actuator and a ball bearing is further removed from the sliding bearing of carriage, the point to point control to the truck center of the light beam based on a tracking error signal comes to be strongly influenced of solid friction which carriage bearing has.
[0005] Drawing 24 is the property of solid friction in the carriage of a single-drive mold. Passing speed V and frictional force F have the value of plus and minus here according to the migration direction of carriage. The case where the passing speed V of carriage changes from minus to plus now is considered. In the passing speed V in which carriage has the value of minus, during migration, it was not concerned with passing speed but the kinetic frictional force F1 of abbreviation regularity has occurred. In case the passing speed V to the guide rail of carriage serves as zero and then begins migration to an opposite direction, it is the static-friction force. - When the driving force exceeding F2 is needed and it begins to move, it is the kinetic frictional force of abbreviation regularity. - It is set to F1.
[0006] At the time of reversal of the passing speed of such carriage, in order for change of the step-force of frictional force to work as disturbance to a control system and to compensate this disturbance enough, generally the large feedback control system of a band is needed.
[0007] Reversal of the passing speed of carriage is produced in the truck follow-up control which compensates a periodic location gap of the truck by the eccentricity of a medium. That is, if carriage is controlled to follow medium eccentricity, the motion to the guide rail of carriage will turn into a

reciprocating motion which synchronized with the eccentric period. For this reason, the passing speed of carriage will be reversed twice [at least] to one revolution of a medium, and the disturbance by change of the step-force of frictional force will be received each time.
[0008] Drawing 24 is as a result of [of the tracking error signal TES over a revolution period (time amount) when a feedback control system performs on-truck control to the head device of a single-drive mold] simulation. In this simulation, 1.1 micrometers and a disk rotational frequency are set to 3600rpm, and coefficient of friction mu is set to 0.3 for the track pitch. Moreover, the band of a feedback control system is set to 1.5kHz in consideration of the high order resonance which has the main resonance in about 15kHz of a actual head device.
[0009] the wave of drawing 25 -- the peak peak eccentricity of an eccentric wave [200] -- 50 micrometers and a wave -- the peak peak eccentricity of an eccentric wave [202] -- 20 micrometers and a wave -- 204 is the case where the peak peak eccentricity of an eccentric wave is 10 micrometers.
[0010] About this neither of wave 200,202,204, eccentric disturbance can fully be oppressed by the aggravation of the low-pass error compressibility ability of a feedback control system and the lowering of a control band resulting from the single drive of a head device. Moreover, in response to the effect of step change of the friction disturbance produced when the passing speed at the time of making carriage follow eccentricity serves as zero, the big peak-like following error 206-1,206-2,206-3,206-4 is produced.
[0011] When the solid friction Ffric accompanying migration of carriage omits static friction here and being expressed briefly, a model is made by the degree type.
[0012]
[Equation 3]

$$F_{fric}=\begin{cases} -\mu m g, & \dot{x} \geq 0 \\ \mu m g, & \dot{x} < 0 \end{cases} \qquad (1)$$

[0013] There is a cause with the compensation difficult for the place which changes suddenly from minus to plus by feedback control in [the sign of solid friction Ffric] step for example, at the time of the reversal of a rate chi to the guide rail of carriage so that clearly from this model.
[0014] Although how to raise the band of a feedback control system generally can be considered as an approach of compensating the friction disturbance of the shape of such a step, there is a limitation by existence of high order resonance near 15kHz. Furthermore, it is difficult by having considered truck follow-up control only as carriage actuation, and having omitted actuation by the lens actuator again to fully raise the control band for positioning.
[0015] This invention aims at offering the storage which compensates friction disturbance certainly in the shape of [resulting from medium eccentricity] a step, and makes a following error small by combining a feedback control system and a learning-control system.
[0016]
[Means for Solving the Problem] Drawing 1 is the principle explanatory view of this invention.
[0017] First, like drawing 1 (A), if optical storage equipment is taken for an example, the storage of this invention The head equipped with the carriage 88 which moves the exposure location of a light beam to the truck location of the arbitration of a medium, The position signal detecting element (tracking error detecting element) 78 and position signal TES which detect and output the position signal (tracking error signal) TES according to the amount of location gaps on the basis of the predetermined location of the truck on a medium based on the light drawn from a medium according to the exposure of a light beam are inputted. The amount of location gaps So that it may consider as zero the carriage 88 of a head It has the feedback operation part 80 which calculates the control signal (control current) IFB for moving, and the actuator (VCM) 86 which drives the carriage 88 of a head so that the exposure location of a light beam may be made to follow a truck based on the control signal IFB of the feedback operation part 80.

[0018] This invention is characterized by forming the learning-control section 82 which gains the strange function for medium revolution 1 round for making the amount of location gaps to periodicity disturbance into zero with learning algorithm as an approximation function which carried out approximation presumption, and memorizes it per such storage.
[0019] In the height Ci of the strip of paper of each section which carried out N division of the time amount for medium revolution 1 round, the strange function for medium revolution 1 round for making into zero the amount of location gaps to periodicity disturbance, such as medium eccentricity which synchronized with the medium revolution period, is gained with learning algorithm as an approximation function which carried out approximation presumption, and, more specifically, the learning-control section 82 memorizes it.
[0020] According to this learning-control section, according to low study gain, even if convergence of a study result takes time amount somewhat, the compensatory signal of the high step friction disturbance of the band accompanying reversal of the carriage migration direction can also be included in the study result obtained eventually. By adding to a feedback system by making this learning-control signal into a feedforward-control signal, most step-friction disturbance is removable, by having considered as the carriage of a single drive, there is a limitation by existence of high order resonance, a following error [as opposed to / that a control band is low / the eccentricity of a medium] is reduced substantially, and the precision of on-truck control can be improved.
[0021] The learning-control section 82 of this invention is formed between the feedback operation part 80 and an actuator 86 like drawing 1 (A). It is tangent line about the time amount for medium revolution 1 round. When it carries out, it is the start time t= 0 of medium 1 revolution to end time t=tangent line. The strange actuation current function Irepeat of drawing 1 (B) to repeat (t) It is the strip of paper Ci (however, i is a section number) of each section with section number i=0- (N-1) which carried out N division of the time amount tangent line for medium revolution 1 round for (however, the time amount which medium 1 revolution takes 0 <=t<tangent line and tangent line). By 0 <=i<= (N-1), it gains by study ARUGORIZU as approximation function I^repeat (t) (however, time amount which medium 1 revolution takes 0 <=t<tangent line and tangent line) which carried out approximation presumption, and memorizes.
[0022] An approximation function is [0023] here.
[Equation 4]
$\hat{I}_{repeat}$

[0024] Although come out and expressed, it is expressing as "I^repeat" in a description. As for this, an approximation function "TES^repeat" is the same.
[0025] Thus, when the learning-control section 82 is formed between the feedback operation part 80 and an actuator 86, since it is study of the actuation current of a feedback control system, few study results of a noise are obtained. Moreover, the part and control which can use a study result as a feed forward current directly at the time of the seeking control and the kickback after study etc., and do not need conversion of a study result at it are easy, and become certain.
[0026] The learning-control section 82 of drawing 1 (A) is equipped with memory, the sample section, approximation function operation part, and the feedforward-control section. Memory is approximation function I^repeat. It has two or more storage cells which store the height Ci of the strip of paper of each section of (t). The sample section samples the control signal IFB outputted from feedback operation part.

[0027] Approximation function operation part is the control signal IFB and the predetermined study gain Klearn which were sampled in the sample section. Approximation function I^repeat which it was based and was stored in each storage cell of memory (t) It is the height Ci of the strip of paper of each section
[0028]
[Equation 5]
$$Ci = Klearn \times I_{FB}$$

[0029] However, it is the number of the section determined by time amount t, and i becomes 0 <=i<= (N-1), for example, it asks for it by the study rule of i=floor (t/T), and T=tangent line/N, and it is updated.
[0030] The feed forward output section (FF output section) is approximation function I^repeat (t) stored in the storage cell of memory synchronizing with the division period T of a medium revolution. The height Ci of the strip of paper of each section is read as a learning-control signal, and it adds to a control signal IFB from feedback operation part, and is a driving signal IVCM to an actuator 86. It supplies.
[0031] Furthermore, it is the control signal IFB and the predetermined study gain Klearn which the sample section sampled the control signal IFB the predetermined period Tsample below the division period T in the detail, and sampled approximation function operation part in the sample section in it. Approximation function I^repeat which it was based and was stored in each storage cell of memory (t) It is the height Ci of the strip of paper of each section [0032]
[Equation 6]
$$C_i^{new} = C_i^{last} + K_{learn} \cdot T_{sample} \cdot I_{FB}(t)$$

[0033] However, i is the number of the section determined by time amount t, and becomes 0 <=i<= (N-1), for example, is i=floor (t/T).
It is alike, and it asks more and updates. However, Cilast expresses Ci value before updating and is Cinew. Ci value after updating is expressed. By this formula, Ci which should be updated in current time t, for example by the calculation result of i by i=floor (t/T) is chosen, and it is IFB (t) to Ci value (Cilast) of that one sample (before Tsample time amount). Derivation considered as an input is performed and the updating result (Cinew) of Ci value in current time t is searched for. IFB (t/T) That updating is not performed to the height Ci of a strip of paper with index numbers other than computed i (Cinew =Cilast in that is, this case). It is as follows when the above processing is summarized.
[0034]
[Equation 7]
$$\begin{cases} C_i^{new} = C_i^{last} + K_{learn} \cdot T_{sample} \cdot I_{FB}(t), & i = floor(t/T)\text{で算出される}i\text{に対して} \\ C_i^{new} = C_i^{last}, & \text{それ以外の}i\text{に対して} \end{cases}$$

[0035] Furthermore, the feed forward output section is approximation function I^repeat (t) stored in the storage cell of memory synchronizing with the sample period Tsample. The height Ci of the strip of paper of each section is read synchronizing with a medium revolution, and it adds to a control signal IFB from feedback operation part, and is a driving signal IVCM to an actuator 86. It supplies.
[0036] The feed forward output section is approximation function I^repeat (t) memorized to each storage cell of memory. The value over the time of day when only predetermined time amount delta tlead progressed is read and outputted. The learning-control section repeats study, carrying out the feed forward output of the study result at the event. In this case, time lags, such as phase lag, are in a feedback control system, and if this is not compensated, control will serve as instability. Then, the newest study result I^repeat in the event (t) It can be related, and where a control system is stabilized with reading and outputting the value corresponding to the time of day when only predetermined time delta tlead progressed from current time, it can learn.
[0037] If it is in another gestalt of this invention, like drawing 1 (C) the learning-control section 104 It is prepared between the position signal detecting element 76 and the feedback operation part 80. It is tangent line about the time amount for medium revolution 1 round. The strange location function TESrepeat repeated by end time t=tangent line from the start time t= 0 of medium 1 revolution when it carries out (t) It is the height Ci (however, i is a section number) of the strip of paper of each section with the section number i which carried out N division of the time amount tangent line for medium revolution 1 round for (however, the time amount which medium 1 revolution takes 0 <=t<tangent line and tangent line). 0<=i -- < (N-1) -- it gains with learning algorithm as approximation function

TES^repeat (t) (however, time amount which medium 1 revolution takes 0 <=t<tangent line and tangent line) which carried out approximation presumption, and memorizes.
[0038] The learning-control section 104 is equipped with memory, the sample section, approximation function operation part, and the feedforward-control section. Memory is approximation function TES^repeat (t). Height Ci of the strip of paper of each section It has two or more storage cells to store. The sample section samples the position signal TES outputted from a position signal detecting element.
[0039] Approximation function operation part is the position signal TES and the predetermined study gain Klearn which were sampled in the sample section. It is the height Ci of the strip of paper of each section of said approximation function TES^repeat (t) which it was based and was stored in each storage cell of memory [0040]
[Equation 8]

$$Ci = Klearn \cdot TES(t)$$

[0041] However, it is the number of the section determined by time amount t, and i becomes 0 <=i<= (N-1), for example, it asks for it by i=floor (t/T), and T=tangent line/N, and it is updated.
[0042] The feed forward output section reads the height Ci of the strip of paper of each section of approximation function TES^repeat (t) memorized to the storage cell synchronizing with the division period T of a medium revolution synchronizing with a medium revolution, adds it to a position signal TES from a position signal detecting element, and is inputted into feedback operation part as feedback signal TESFB.
[0043] Furthermore, if it explains to a detail, the sample section will sample a position signal TES the predetermined period Tsample below the division period T. Approximation function operation part is the position signal TES and the predetermined study gain Klearn which were sampled in the sample section. It is the height Ci of the strip of paper of each section of approximation function TES^repeat (t) which it was based and was stored in each storage cell of memory [0044]
[Equation 9]

$$C_i^{new} = C_i^{last} + K_{learn} \cdot T_{sample} \cdot TES(t)$$

[0045] However, i is the number of the section determined by time amount t, and becomes 0 <=i<= (N-1), for example, is i=floor (t/T).
It is alike, and it asks more and updates. However, Cilast expresses Ci value before updating and Cinew expresses Ci value after updating. By this formula, for example, Ci which should be updated in current time t by the calculation result of i by i=floor (t/T) is chosen, derivation which considers TES (t) as an input is performed to Ci value (Cilast) in front of that 1 sample (before Tsample time amount), and the updating result (Cinew) of Ci value in current time t is searched for. That updating is not performed to the height Ci of a strip of paper with index numbers other than i computed by i=floor (t/T) (Cinew =Cilast in that is, this case). It is as follows when the result of the above treatment is summarized.
[0046]
[Equation 10]

$$\begin{cases} C_i^{new} = C_i^{last} + K_{learn} \cdot T_{sample} \cdot TES(t), & i = floor(t/T)\text{で算出される}i\text{に対して} \\ C_i^{new} = C_i^{last}, & \text{それ以外の}i\text{に対して} \end{cases}$$

[0047] Furthermore, the feed forward output section reads the height Ci of the strip of paper of each section of approximation function TES^repeat (t) memorized to the storage cell synchronizing with the sample period Tsample synchronizing with a medium revolution, adds it to a position signal TES from a position signal detecting element, and is inputted into feedback operation part as feedback signal TESFB.
[0048] Also in the case of this drawing 1 (C), the feed forward output section reads and outputs the value over the time of day when only predetermined time amount delta tlead progressed approximation function TES^repeat memorized to each storage cell of memory.

[0049] The learning-control section 82,100 is approximation function I^repeat (t) gained with learning algorithm after study. Or TES^repeat (t) Feedforward control is outputted and carried out synchronizing with a medium revolution.
[0050] Only specific time amount performs acquisition actuation of the approximation function by learning algorithm to the timing immediately after insertion of the medium to equipment, and the learning-control section 82,100 performs feedforward control which outputs the gained approximation function synchronizing with a medium revolution at the time of the tracking control after study, and removes periodicity disturbance.
[0051] Moreover, the learning-control section performs feedforward control which outputs the gained approximation function synchronizing with a medium revolution at the time of the track jump after study, and seeking control, and removes periodicity disturbance.
[0052] A store may produce an error and the approximation function of approximation gained when it sought and moved to other radial locations when it learns a disk radial specific location, for example, near the periphery in a disk, and an approximation function is obtained, and truck control was performed may be [a store] inadequate. For example, when the roundness of the truck of a disk can differ on inner circumference and a periphery, the difference in the inside-and-outside periphery of the phase of periodic disturbance or the amplitude accompanying a spindle revolution cannot be disregarded or it uses the pickup with the structure of coarseness one apparatus, fricative magnitude may differ on inner circumference and a periphery.
[0053] Then, the learning-control section 82 of this invention does not call at the track address which carries out an on-truck, but can realize highly precise truck control by performing acquisition actuation of an approximation function in two or more parts, and choosing and (for example, the approximation function by which study acquisition was carried out in the nearest track address being chosen) acting as the feedforward of the approximation function according to the track address which is carrying out the on-truck then corresponding to the radial location of a disk, at the time of feedforward.
[0054] Moreover, since the fundamental wave of an approximation function does not almost have a difference and the difference of each approximation function turns into a delicate difference, when carrying out acquisition actuation of an approximation function by two or more places in this way, When there is approximation function data in other parts, initial value (initial value of the value of the cel equivalent to each strip of paper) of the approximation function data in approximation function acquisition actuation in this part is not started from zero. Compaction of learning time can be aimed at by starting the approximation function data in other parts as initial value.
[0055] In the case of optical storage equipment, a head is carried for an objective lens on the carriage which can move in the direction which crosses the truck of a medium freely, enabling focal free control, and is equipped with the structure of a single-drive mold of performing both tracking control which makes a light beam following a truck by migration of carriage, and seeking control which moves a light beam to the truck location of arbitration.
[0056]
[Embodiment of the Invention] Drawing 2 is the store of this invention and has taken the optical disk drive for the example. The optical disk drive of this invention consists of a control unit 10 and enclosure 11.
[0057] MPU12 which performs overall control of an optical disk drive, the interface 17 which performs an exchange of a command and data between high order equipment, the optical disk controller (ODC) 14 which performs processing required for the read/write of data to an optical disk medium, DSP16, and buffer memory 18 are formed in a control unit 10.
[0058] Buffer memory 18 is shared with MPU12, the optical disk controller 14, and the high order interface 17. A formatter and an ECC unit are prepared in the optical disk controller 14. At the time of light access, a formatter divides NRZ light data per sector of a medium, a record format is generated, and an ECC code is generated and added, and if an ECC unit is required, it will generate and add the CRC code to a sector light data unit.
[0059] Furthermore, the sector data with which ECC encoding ended are changed for example, into a 1-

7RLL sign. At the time of read access, after carrying out 1-7RLL inverse transformation of the sector lead data and then carrying out CRC check in an ECC unit, error detection correction is carried out, the NRZ data of a sector unit are further connected by the formatter, and it is made to transmit to high order equipment as a stream of NRZ lead data.

[0060] Wright LSI 20 is formed to the optical disk controller 14, and the Wright modulation unit and a laser diode control unit are prepared for Wright LSI 20. The laser diode unit 30 is equipped with a laser diode and the detector for monitors. Wright LSI 20 changes light data into the data format in PPM record or PWM record (it is also called mark record or edge record).

[0061] It can use whether they are 128MB, 230MB, 540MB, 640MB, and 1.3GB grade as the optical disk which performs record playback using the laser diode unit 30, i.e., a rewritable MO cartridge medium. Among these, about 128MB of MO cartridge medium, the pit position record (PPM record) which records data corresponding to the existence of the mark on a medium is adopted. Moreover, a record format of a medium is Zone CAV and 128MB medium of the number of zones of a user area is one zone. Moreover, about 230MB, 540MB, 640MB, and 1.3GB of MO cartridge medium used as high density record, the pulse width record (PWM record) whose edge of a mark, i.e., first transition and a trailing edge, is made to correspond to data is adopted.

[0062] Here, the difference of the memory capacity of 640MB medium and 540MB medium is based on the difference in sector capacity, when sector capacity is 2048 bytes, it is set to 640MB, and on the other hand, it is set to 540MB at the time of 512 bytes. Moreover, a record format of a medium is Zone CAV and, for 230MB medium, ten zones, 540MB medium, and 1.3GB medium are [18 zones and 640MB media of the number of zones of a user area] 11 zones.

[0063] thus, the optical disk drive of this invention -- 128MB and 230MB -- 640MB of 540MB [1.3GB of] can respond to MO cartridge of each memory capacity, such as 230MB corresponding to a direct exaggerated light, 540MB, and 640 etc.MB, further.

[0064] Therefore, when loading of the MO cartridge is carried out to an optical disk drive, the ID section of a medium is led first, the classification of a medium is recognized in MPU12 from the pit spacing, and a classification result is notified to the optical disk controller 14.

[0065] As a lead system to the optical disk controller 14, lead LSI 24 is established and, as for lead LSI 24, a lead recovery unit and a frequency synthesizer are built in. To the lead LSI 24, the light-receiving signal of the return light of the beam from the laser diode by ID / detector 32 for MO prepared in the enclosure 11 is inputted as ID signal and an MO signal through the head amplifier 34.

[0066] Circuitry, such as an AGC circuit, a filter, and a sector mark detector, was prepared in the lead LSI 24, a lead clock and lead data were created and PPM data or PWM data is recovered from ID signal and MO signal which were inputted to the original NRZ data. Moreover, since Zone CAV is adopted, setting-out control of the division ratio for generating the clock frequency corresponding to a zone from MPU12 to the frequency synthesizer built in the lead LSI 24 is performed.

[0067] A frequency synthesizer is the PLL circuit equipped with the programmable divider, and generates a reference clock with the frequency of the proper beforehand defined according to the zone location of a medium as a lead clock. That is, a programmable divider consists of PLL circuits equipped with the programmable divider, and generates the reference clock of a frequency fo according to the division ratio (m/n) which MPU12 set according to the zone number according to a degree type.

[0068] fo= (m/n) and fi -- here, the dividing value n of the denominator of a division ratio (m/n) is a value of the proper according to the classification of 128MB, 230MB, 540MB, or 640MB medium. Moreover, the dividing value m of a molecule is a value which changes according to the zone location of a medium, and is beforehand prepared as table information on the value corresponding to a zone number per each medium.

[0069] The lead data to which it restored with lead LSI 24 are given to the lead system of the optical DIKUSU controller 14, and NRZ sector data are restored by the decoding function of an ECC unit in response to CRC check and ECC processing after inverse transformation of 1-7RLL.

[0070] Then, it changes into the stream of NRZ lead data which connected NRZ sector data by the formatter, and is transmitted to high order equipment with the high order interface 17 via buffer memory

18. To MPU12, the detecting signal of the temperature sensor 36 formed in the enclosure 11 side via DSP16 is given. MPU12 controls the lead in the laser diode unit 30, Wright, and each luminescence power of erasion to an optimum value based on the environmental temperature of the unit in equipment detected with the temperature sensor 36.
[0071] MPU12 controls the spindle motor 40 formed in the enclosure 11 side by the driver 38 via DSP16. Since a record format of MO cartridge is Zone CAV, it rotates a spindle motor 40 with the constant speed of for example, 3000rpm.
[0072] Moreover, MPU12 controls the magnetic field impression unit 44 using the electromagnet formed in the enclosure 11 side through the driver 42 via DSP16. In equipment, the magnetic field impression unit 44 is arranged in the opposite hand the beam exposure side of MO cartridge by which loading was carried out, and supplies an external magnetic field to a medium at the time of elimination etc. at the time of record.
[0073] DSP16 is equipped with the servo function for positioning the beam from a laser diode 30 to a medium, and performs seeking control (robust control: coarse control) for seeking and carrying out an on-truck to the object truck, and tracking control (energy control: fine control).
[0074] This seeking control and tracking control can be simultaneously performed in parallel to light access or read access to the high order command by MPU12.
[0075] In order to realize the servo function of DSP16, the detector 45 for FES which receives the beam return light from a medium to the optical unit by the side of the enclosure 12 was formed, and the FES detector (focal error signal detector) 46 created the focal error signal from the light-receiving output of the detector 45 for FES, and has inputted into DSP16.
[0076] Moreover, the detector 47 for TES which has six division or the hyperfractionation light sensing portion said comparatively for 9 minutes which receives the beam return light from a medium in the optical unit by the side of the enclosure 11 was formed, the TES detector (tracking error signal detector) 48 created the tracking error signal from the light-receiving output of the detector 47 for TES, and it has inputted into DSP16.
[0077] In this example, a truck king error signal is generated by the push pull method (it is also called the far field method). The tracking error signal was inputted into the TZC detector (truck zero cross detector) 50, created the truck zero cross pulse and has inputted it into DSP16. Furthermore, DSP16 is controlling the focal actuator 52 and VCM54 through drivers 55 and 58 in order to control the location of the beam spot on a medium.
[0078] The outline of the enclosure 11 in an optical disk drive becomes like drawing 3 here. A spindle motor 40 is formed in housing 60, and loading by which the hub of the revolving shaft of a spindle motor 40 is equipped with the internal MO medium 66 is performed by inserting the MO cartridge 64 from an inlet door 62 side to the hub of the revolving shaft of a spindle motor 40.
[0079] A head device consists of carriage 68, an objective lens 70, fixed optical system 72, and a mirror 74. The carriage 68 which can move in the direction which crosses the truck of a medium by VCM54 freely is formed in the MO medium 66 bottom of the MO cartridge 64 by which loading was carried out.

[0080] An objective lens 70 is carried on carriage 68, the beam from the laser diode prepared in the fixed optical system 72 is started, incidence is carried out through a mirror 74, and image formation of the beam spot is carried out to the medium side of the MO medium 66. Migration control of the objective lens 70 is carried out in the direction of an optical axis by the focal actuator 52 shown in the enclosure 11 of drawing 2 . Moreover, a light beam is movable to radial [which crosses the truck of a medium by linear actuation of the carriage 68 by VCM54].
[0081] Carriage 68 is supported by the sliding bearing by two guide rails placed in a fixed position, and performs simultaneously seeking control for which the light beam known as robust control (KOASU) is moved to the truck location of arbitration, and tracking control known as energy control (fine control) in which a light beam is made to follow a truck center in the sought truck location.
[0082] Things, such as JP,9-312026,A and JP,9-54960,A, can be used as a head device of such a single-drive mold.

[0083] Drawing 4 is the 1st operation gestalt of the feedback control system of the head device in the store of this invention. If it is in this 1st operation gestalt, it is characterized by preparing the learning-control section between the feedback control section and a carriage actuator.
[0084] In drawing 4 , the feedback control system of a head device consists of the tracking error detecting element 78, the feedback control section 80, the learning-control section 82, an adder 84, a carriage actuator 86, and carriage 88. The tracking error which is the difference of the truck location which sways with the eccentricity of a medium, and the location of a light beam is detected optically, and tracking error detection equipment 78 outputs it, as shown in drawing 4 .
[0085] The eccentric disturbance by the eccentricity of a medium joins the input of this tracking error detecting element 78 from a summation point 76. The feedback control section 80 moves carriage 88 by the carriage actuator 86 so that the amount of gaps to the truck center of a light beam may be lost by making the tracking error signal TES into zero.
[0086] A control signal IFB is outputted by the PID operation, and the feedback control section 80 serves as a feedback current command value to the carriage actuator 86 using VCM54 which showed this control signal IFB to drawing 2 .
[0087] The learning-control section 82 inputs the control signal IFB as a feedback current command value outputted from the feedback control section 80. After gaining learning-control signal I^repeat which is the approximation function of the strange actuation current function Irepeat for oppressing following errors, such as friction disturbance of the periodicity accompanying an eccentric revolution of a medium, and eccentric disturbance, by the study rule and completing study Learning-control signal I^repeat obtained as a study result is outputted synchronizing with a medium revolution.
[0088] It adds to a control signal IFB as a feedforward control signal from the feedback control section 80 with an adder 84, and this learning-control signal I^repeat is a driving signal IVCM. It becomes. Driving signal IVCM Carriage 88 is driven through the carriage actuator 86. Big friction disturbance has joined carriage 88 periodically as force disturbance 90 at the flash when a direction changes in abbreviation step at the event of passing speed zero like drawing 23 with reversal of the passing speed by the reciprocating motion of the carriage 88 accompanying an eccentric revolution of a medium.
[0089] Drawing 5 is the functional block diagram of the learning-control section 82 of drawing 4 . The learning-control section 82 is equipped with a control section 92, the sample processing section 94, the approximation function operation part 96, the ring buffer memory 98, and the feedforward output section (henceforth "FF output section") 100 in drawing 5 .
[0090] The clock signal E1 and the index signal E2 obtained synchronizing with one revolution of a medium have inputted into the control section 92. A control section 92 sets up (1) learning-mode (2) study result output mode as a mode of operation of the learning-control section 82.
[0091] Learning mode is performed in the case of the load processing after inserting a medium, and learns learning-control signal I^repeat which serves as an approximation function of periodicity according to a study rule. In study result output mode, a study rule outputs learning-control signal I^repeat obtained as a study result synchronizing with a medium revolution, without operating, and adds it as a feedforward output to a feedback control system.
[0092] For this reason, if a control section 92 is in learning mode, it operates the sample processing section 94, the approximation function operation part 96, the ring buffer memory 98, and FF output section 100, and if it is in the study result output mode after study termination, it operates the ring buffer memory 98 and FF output section 100.
[0093] The learning algorithm adopted by this invention by the approximation function operation part 96 prepared in the learning-control section 82 of drawing 5 here is explained.
[0094] Actuation current IVCM which drives carriage 88 in the feedback control system of drawing 4 synchronizing with a medium revolution It can regard as a current pattern as regarded as most being the repetition signal of the period which synchronized with the medium revolution, for example, shown in drawing 6 . The current pattern repeated periodically is regarded as a strange actuation current function Irepeat (t) like this drawing 6 , and it is the period tangent line of medium 1 revolution like drawing 6 . It considers carrying out an approximation expression in the height of the strip of paper which carried out

N division. The time amount width of face T of the one strip-of-paper neighborhood which carried out N division here is T=tangent line/N. .
It becomes.
[0095] If the height of each strip of paper which carried out N division of the current pattern of drawing 6 is set to Ci (however, i= 0, 1, ... N-1), approximation function I^repeat will become like a degree type.
[0096]
I^repeat(t)=Ci (2)
However, i=floor (t/T)
T=tangent line / N0 <=t<tangent line -- the floor ( ) function of (2) types is smaller than the argument in ( ), or shows the greatest equal integral value here. For example, it is set to floor(0-0.9) =0 when the arguments in ( ) are (0-0.9). Moreover, it is set to floor(1.0-1.9) =1 when the arguments in ( ) are (1.0-1.9). It is reset by the index signal obtained when decided for every medium revolution, therefore time of day t is t= 0 - tangent line. It has a value.
[0097] When the height Ci of each strip of paper of approximation function I^repeat of the aforementioned (2) formula integrates with the control signal IFB which is a feedback current command value in the time amount width of face corresponding to a strip of paper, study advances according to a degree type.
[0098]
[Equation 11]

$$\dot{C}i = \mathrm{Klearn} \cdot I_{FB}(t) \qquad (3)$$

[0099] However, i=floor (t/T)
It is Klearn of (3) types here. It is study gain and is a forward constant. (3) Choose the strip of paper Ci which determines i, that is, is made applicable to study according to the value of t as shown in a formula, and it is the value IFB of the control signal at that time (t). The integration operator considered as the input is performed. Since according to the study rule according to this (3) type the height of each strip of paper finds the integral until IFB which is the input of a study rule becomes abbreviation zero, after study convergence is strip-of-paper C0 -CN-1. Approximation function I^repeat expressed (t) Itepeat which is a strange actuation current function (t) It becomes the approximated function.
[0100] And study result I^repeat(t) =Ci according to (3) types, however i=floor (t/T)
T=tangent line / N0 <=t<tangent line is the actuation current IVCM of the carriage actuator 86 which becomes a feedforward output in study result output mode, and drives carriage 88. Since it is put in directly, it seems that repetition disturbance with periodicity was extinguished, in view of a feedback control system.
[0101] The compensation approach of the periodicity disturbance by study of such this invention is the study gain Klearn for study, even if convergence for obtaining a study result takes time amount somewhat. Even if it is low gain, the learning-control signal acquired eventually can include the high signal of a frequency band, and the high compensatory signal of the frequency band to the repetition disturbance which has periodicity strictly.
[0102] (3) Height Ci for every strip of paper called for according to the study rule of a formula It is stored in the memory cell to which the ring buffer memory 98 corresponds.
[0103] Drawing 7 is the memory configuration of the ring buffer memory 98 prepared in the learning-control section 82 of drawing 5 . The ring buffer memory 98 is the period tangent line of medium 1 revolution. Corresponding to the number of partitions N, it has the memory cell 106-0 of N individual - 106- (N-1). Height Ci of each strip of paper computed by (3) types synchronizing with a disk revolution A value is stored in the cell address i of a memory cell 106-0 - 106- (N-1) as mem [i].
[0104] Namely, the time amount t shown corresponding to the location of the memory cell 106-0 of the ring buffer memory 98 of drawing 7 - 106- (N-1) is time amount reset by the index signal obtained for every revolution of a medium, it sets to t= 0 time amount of the revolution starting position where the index signal was obtained, and this event is detected as an origin for every medium revolution.
[0105] The long time amount width of face T of the strip of paper shown in drawing 6 here to sampling

period Tsample of the input signal IFB by the sample processing section 94 of drawing 5 is taken. In the sample time of day t, it is decided by calculation of the address i of a degree type whether to apply the study operation of (3) types for the memory cell of ring buffer memory 98 throat.
i=floor(t/T) (4)
T is the time amount width of face of the strip of paper of drawing 6 , and is T=tangent line/N here. For example, if a medium rotational frequency is set to 4500rpm, a rotational frequency is 75Hz, the period tangent line of 1 revolution is tangent line =13.3msec, and it is the 1 period tangent line. For example, suppose that it divided into N= 128. In this case, the time amount width of face T per strip of paper serves as T=tangent line / N= 104.2microsec.
[0106] Therefore, when the sampling frequency of the control signal IFB from the feedback control section 80 to the learning-control section 82 is made into 55kHz, i.e., sampling period Tsample=18.18microsec, the sampling of a control signal IFB will be performed about 5 times in the time amount width of face T of one strip of paper. That is, per medium 1 revolution and each strip of paper will perform the study operation of (3) types by a unit of about 5 times.
[0107] (3) The study operation at the time of implementing the study rule of a formula in DSP actually is given by the degree type.
mem[i] = mem[i]+Klearn and Tsample-IFB (t) (5)
However, i=floor (t/T)
The result of an operation stored in the memory cell 106-0 of drawing 7 - 106- (N-1) so that clearly from this (5) type is the study gain Klearn. It is the integration operator which considers as integral gain and considers a control signal IFB as an input. That is, it becomes the processing memorized after reading and adding the study result mem [i] which has memorized last time {Klearn xTsamplexIFB (t)} computed for every sample timing to the memory cell of the corresponding address i.
[0108] About the height Ci of each strip of paper, when the operation of (5) types is explained, it is as follows. That is, initial value (usually zero) is set as mem [i] before study. After study initiation, between the specific time amount of **** of a disk revolution (i.e., while i=floor (t/T) is filled), the height Ci of the strip of paper is chosen, and the integration operator of (5) types for mem [i] is performed by considering IFB (t) in the time of day as an input.
[0109] Other strips of paper are chosen as the other time amount, and same processing is carried out to it. While other strips of paper are chosen, renewal of the value of mem [i] is not performed. When a disk rotates one time and a strip of paper Ci is chosen again, the integration operator of (5) types is further performed by making the integral result to the revolution before mem [i] is already stored into initial value, and it dies.
[0110] If it is in learning mode, feedforward control which FF output section 100 similarly reads the result of an operation of the memory cell of the ring buffer memory 98 corresponding to the integral processing and coincidence in a memory cell to which the ring buffer memory 98 of the result of an operation of the approximation function operation part 96 according to (5) types corresponds, adds with the adder 84 of drawing 4 , and adds to a feedback control system is performed.
[0111] The approximation function operation part 96 of drawing 5 is T= 0 to T=tangent line until an index signal E2 is obtained from the time amount t= 0 if it was in learning mode, when an index signal E2 is obtained next. About time amount progress of until (4) A cell address i is computed by the formula and the read-out output of that study result when receiving storing of the result of an operation Ci by the approximation function operation part 96 and FF output section 100 with the output of the address control signal over the ring buffer memory 98 is performed.
[0112] The learning-control section 82 of drawing 5 shifts to study result output mode, after the study processing according to the learning mode in load processing of a medium is completed. If it is in study result output mode, a control section 92 operates the ring buffer memory 98 and FF output section 100, and it synchronizes with the index signal E2 obtained for every medium revolution. For example, learning-control signal I^repeat as the last study result is read the same read-out period as sampling period Tsample in learning mode. Output to the adder 84 of drawing 4 from FF output section 100, and it adds to the control signal IFB then acquired from the feedback control section 80. It is the actuation

current IVCM to the carriage actuator 86. Feedforward control is performed so that it may pass and the periodic friction disturbance accompanying medium eccentricity for carriage 88 may be oppressed.
[0113] In order to guarantee the stability of the study processing in learning mode here, in case that study result when storing in the ring buffer memory 98 in FF output section 100 is outputted to a feedback control system, in consideration of time lags, such as phase lag of a controlled system, it is necessary to carry out the feedforward output of the study result of having progressed in time.
[0114] What is necessary is to choose a memory cell corresponding to the progress time amount in consideration of the phase lag of a controlled system, and just to output the study result at that time for the feedforward output of this study result of having progressed in time, since the current pattern which serves as a feedforward output corresponding to time amount t is managed as shown in drawing 6 if it is not necessary to use the so-called phase-lead-lag-network filter etc. and is in the learning-control section 82.
[0115] That is, when elapsed time from the medium 1 revolution initiation event from which an index signal is obtained was set to t, the memory cell which memorizes a study result was chosen by (4) formulas, but for [by FF output section 100] a feedforward output, selection of a memory cell will be computed by the degree type, if progress time amount is set to deltatlead.
[0116]
[Equation 12]

$$\begin{cases} i = floor\{(t + \Delta t_{lead})/T\} & if\ 0 \le t < (T_L - \Delta t_{lead}) \\ i = floor\{(t + \Delta t_{lead} - T_L)/T\} & if\ (T_L - \Delta t_{lead}) \le t < T_L \end{cases} \quad (6)$$

[0117] (6) it is shown in the 1st formula of a formula -- as -- fundamental -- time of day t -- progressing -- time amount deltatlead -- a guide peg -- determine the memory cell number i based on time amount the bottom. However, <=(tangent line-deltatlead) t<tangent line when t exceeds (tangent line-deltatlead) In a case, the memory cell number i is computed according to count as shown in the 2nd formula of (6) types. That is, t will return and read from the flash exceeding (tangent line-deltatlead) to the head of a ring buffer.
[0118] Thus, by performing lead compensation about the feedforward output of a study result, the response waveform when not performing lead compensation can obtain the study result that becoming in oscillation was prevented and stabilized.
[0119] Drawing 8 is the flow chart of the point to point control in the store of this invention equipped with the learning-control section 82 of drawing 4 . If a medium is first loaded to equipment at step S1, medium load processing in which the medium load sequence predetermined at step S2 was followed will be performed. In this medium load processing, processing by the learning mode of step S3 by the learning-control section 82 newly prepared by this invention is performed.
[0120] As for termination of the study processing by this learning mode, study **** is judged by assessment of the count of (1) study (2) learning-time (3) tracking-error signal TES etc. For example, when performing the termination judging of study by time setting, the turnover number of the disk after study initiation is counted, and it considers as termination by the count of a convention.
[0121] If study termination is checked by step S4, it will progress to step S5 and will shift to processing of study result output mode. If it is in this study result output mode, a feedforward output will be carried out at a feedback control system by making into a fixed value the study result acquired at step S3.
[0122] For this reason, if it is in the seeking control after step S6, and tracking control, and the eccentric disturbance which synchronized with the revolution of a medium, especially the peak friction disturbance which occurs to the timing of the passing speed zero accompanying both-way migration of the carriage corresponding to medium eccentricity are effectively oppressed by the feedforward output based on a study result and it sees from a feedback control system with it, the stable controlled environment without periodic disturbance is acquired.
[0123] for this reason, seeking **** which progresses to step S7, it will turn to a target truck, and will control the speed and will position carriage if it is in the processing after the study result output mode of

step S5 and there is seeking control at step S6 -- if the so-called robust control (coarse control) performs and an on-truck carries out to a target truck at step S8 by this seeking control, the tracking control which makes a light beam follow a target truck center by step S9 will perform.

[0124] The seeking control of step S6 - S9 or on-truck control corresponding to processing of the study result output mode of this step S5 is repeated until medium blowdown is distinguished at step S10, and when there is medium blowdown, study processing by the learning mode of step S3 will be again performed to step S1 anew with return and the following medium load. Moreover, if there are termination directions at step S11, a series of processings will be ended.

[0125] At the time of acquisition actuation of an approximation function, the processing by the learning mode of step S4 by the learning-control section 82 is two or more places of a disk radial location, and performs acquisition actuation of the approximation function to each part here. At this time, the learning-control section 82 applies learning algorithm to it by making the approximation function data which has already existed into initial value, when the approximation function already gained in another part exists in the approximation function acquisition actuation by two or more places.

[0126] Moreover, if the learning-control section 82 is in processing of the study result output mode of step S5 used as the time of the feedforward after study, it chooses and acts as the feedforward of the approximation function used according to the radial location at that time.

[0127] For example, the example which has 15000 trucks in from the inner circumference of a disk before a periphery is considered. First, approximation function acquisition actuation is performed near 7500 Motome which turns into near an inside periphery. Next, the memory cell for the approximation function acquisition for inner circumference which carries out seeking migration and is independently prepared near 2500 Motome near 2500 Motome for approximation function acquisition near inner circumference is used, and approximation function acquisition actuation is performed.

[0128] Next, the memory cell for the approximation function acquisition for peripheries which carries out seeking migration and is independently prepared near 12500 Motome near 12500 Motome for the approximation function acquisition near a periphery is used, and approximation function acquisition actuation is performed. Supposing study finishes with 100 disk revolutions, study performed by 7500 Motome will be performed between 7500 Motome and 7600 Motome, for example.

[0129] Since the approximation function is mostly considered to be an equal in study by the inner circumference performed after that with the function gained by the inside periphery By not starting initial value (initial value of each value of a memory cell) of an approximation function from zero, but copying the study result in an inside periphery to the memory cell of inner circumference, and starting study by making it into initial value, compaction of study can be performed, for example, it can end by 50 disk revolutions. Compaction of learning time is similarly attained by study on a periphery.

[0130] The above is performed for example, at the time of a medium load. The object for inner circumference, the object for inside peripheries, and three approximation functions for peripheries are prepared. In future working states, in moving to the truck to 1 to 5000 Motome and carrying out read/write actuation, it acts as the feedforward of the approximation function gained near 2500 Motome.

[0131] Moreover, in moving to the truck from 5001 Motome to 10000 Motome and carrying out read/write actuation, it acts as the feedforward of the approximation function gained near 7500 Motome. It moves to the truck from further 10001 Motome to 15000 Motome, and in carrying out read/write actuation, it acts as the feedforward of the approximation function gained near 12500 Motome.

[0132] It compares, when using the approximation function obtained near [one] the inside periphery by the above in the whole region from inner circumference to a periphery. And the difference in the inside-and-outside periphery of the phase of periodic disturbance or the amplitude accompanying a spindle revolution cannot be disregarded, or [that the roundness of the truck of a disk differs on inner circumference and a periphery] When using the pickup with the structure of a single-drive mold, even if fricative magnitude may differ on inner circumference and a periphery, highly precise truck flattery actuation can be performed.

[0133] Drawing 9 is the flow chart of the study processing in the case of the learning mode in the

learning-control section 82 of drawing 5 . If it is in this study processing, it is step S1 first, and the existence of the index obtained for every medium revolution is checked, and if an index is obtained, it will progress to step S2, and current time t is reset to t= 0, and it confirms whether to be sample timing at step S3.

[0134] If it is sample timing, the current indicated value IFB as a control signal will be sampled by step S4, the address i of a memory cell will be calculated based on (4) types from the time of day t at that time at step S5, and the storing value mem of a cell address i [i] will be read at step S6.

[0135] Then, at step S7, the new storing value mem [i] is computed according to (5) types, and the storing value newly calculated in the cel of memory is memorized and updated by step S8. Then, by step S9, the storing value of a front cell address is read by the cell address, i.e., control time amount deltatlead, computed by (6) formulas, and a feedforward output is carried out to a feedback control system. Such processing of step S1 - S9 is repeated until it reaches a study terminating condition, for example, the learning time set up beforehand, at step S10.

[0136] Drawing 10 is the flow chart of feedforward output processing in the study result output mode of the learning-control section 82 of drawing 5 . If it is in this feedforward output processing, and the existence of the index obtained for every medium revolution at step S1 is checked and an index is obtained, current time t will be reset to t= 0 at step S2, and it will confirm whether to be output timing at step S3.

[0137] This output timing is taken as the timing decided the same output period as sampling period Tsample in the case of the learning mode of drawing 9 . If output timing is distinguished at step S3, the address i of the memory cell based on the time amount which progressed by (6) types by step S4 at current time t, and added time amount deltatlead will be calculated, the storing value of a cell address will be read at step S5, and a feedforward output will be carried out to a feedback control system. And a feedforward output will be ended, if there is medium blowdown at step S6 or there are termination directions of equipment at step S7.

[0138] Drawing 11 is the tracking error signal TES from the study initiation by the learning-control section 82 in the 1st operation gestalt of drawing 4 to study termination, feedback control signal IFB, learning-control signal I^repeat, and the carriage driving signal IVCM. It is a wave explanatory view and the axis of abscissa expresses time amount with the second.

[0139] here -- drawing 11 (A) -- the tracking error signal TES and drawing 11 (B) -- feedback control signal IFB and drawing 11 (C) -- learning-control signal I^repeat -- further -- drawing 11 (D) -- carriage driving signal IVCM it is .

[0140] In this drawing 11 , study processing is started from time of day t0. If it is immediately after study initiation of time of day t0, the tracking error signal TES of drawing 11 (A) expresses the big location gap by peak-the friction disturbance and eccentricity which are produced in the passing speed zero of the carriage accompanying medium eccentricity. This tracking error signal TES is gradually decreased with progress of study, and friction disturbance and a location gap are oppressed eventually.

[0141] In addition, in one revolution of the beginning immediately after the study start time t0, since only predetermined time delta tlead is read from the early cel to the storage cell which reads a study result to the storage cell which writes in a study result, learning-control signal I^repeat serves as initial value zero before study.

[0142] The study processing from time of day t0 turns into processing which moves gradually the disturbance component contained in the feedback control signal IFB of drawing 11 (B) to learning-control signal I^repeat outputted as a study result like drawing 11 (C). And if it results in time-of-day 0.2-0.25sec by the side of study termination, most disturbance components contained in the feedback control signal IFB of drawing 11 (B) at the time of study initiation will be moved to the learning-control signal Irepeat used as the feedforward output of drawing 11 (C), consequently disturbance will no longer be looked at by the tracking error signal TES of drawing 11 (A).

[0143] Drawing 12 is time-of-day 0.01-0.05sec of drawing 11 . The becoming study initiation part is expanded and expressed with the time-axis. If shown in drawing 12 , study is started from time of day t0, and the tracking error by the big eccentricity of the medium to a truck center and the tracking error

by the peak friction disturbance in the passing speed zero of carriage are produced to the tracking error signal TES of drawing 12 (A) at this event.

[0144] Drawing 13 is time-of-day 0.1-0.14sec of drawing 11 . It is a wave in the middle of the study which expanded and expressed the wave with the time-axis. This drawing 13 (A) If it is in the wave in the middle of study of - (D) As compared with the time of study initiation of drawing 12 , to learning-control signal I^repeat of drawing 13 (C) as a study result The disturbance component of the feedback control signal IFB of drawing 13 (B) is mostly moved, consequently the peak location gap by the friction disturbance of the tracking error signal TES of drawing 13 (A) is oppressed, and the location gap by the eccentricity as the whole is also oppressed.

[0145] Drawing 14 (A) - (D) is the wave form chart expanded on the time-axis about near the study termination used as time-of-day 0.2-0.25sec of drawing 12 . If it is in the wave at the time of this study termination, most disturbance of the tracking error signal TES of drawing 14 (A) which a disturbance component is moved to learning-control signal I^repeat of drawing 14 (C) nearly thoroughly, and turns into a feedback signal of a feedback control system is oppressed by extent which can be disregarded.

[0146] Drawing 15 is the wave of each part in the study processing at the time of not performing compensation by progress time amount deltatlead for compensating the time delay of a feedback control system in FF output section 100 of the learning-control section 82 of drawing 5 , and expands and shows the wave near study termination of the time of day 0.2-0.25 of drawing 15 to drawing 16 on the time-axis. Here, they are the tracking error signal TES, learning-control signal I^repeat, and the carriage driving signal IVCM. A wave is shown and the feedback control signal IFB is omitted.

[0147] In addition, the storage cell which writes in a study result when not performing compensation by progress time amount deltatlead, and the storage cell which reads a study result become the same, therefore it is time of day t0. The output of learning-control signal I^repeat is obtained from the beginning.

[0148] When processing only whose progress time amount delta tlead for compensating the time delay of a feedback control system in the case of a feedforward output brings read-out timing forward is not performed so that clearly from the wave of this drawing 15 and drawing 16 , in response to the effect by the time delay of a feedback control system, a response waveform becomes in oscillation.

[0149] Consequently, it is clear that the oscillating component by delay will be moved also to learning-control signal I^repeat outputted as a study result of drawing 16 at the study termination event of drawing 16 (C) as a study result, and the oppression effectiveness of sufficient disturbance component cannot be expected. On the other hand, a good study result as shown in drawing 11 - drawing 14 in FF output section 100 of drawing 5 with the output of the according to setting out of time amount spontaneously study result corresponding to the time delay of a feedback control system is obtained.

[0150] moreover, when the learning-control section 82 of drawing 4 is formed between the feedback control section 80 and the carriage actuator 86 Since the feedback current to the carriage actuator 86 outputted from the feedback control section 80 itself is made applicable to study, A wave with few noises can be learned, and since a study result is the feedback current itself, there is an advantage which outputs as a feedforward current in the cases, such as seeking control, on-truck control, and kickback control, and can be used for a direct feedback control system at them.

[0151] Drawing 17 is the 2nd operation gestalt of the point-to-point control of the head of the storage of this invention, and if it is in this 2nd operation gestalt, it is characterized by preparing the learning-control section between a tracking error detecting element and the feedback control section.

[0152] In drawing 17 , a feedback control system consists of the tracking error detecting element 78, the feedback control section 80, a carriage actuator 86, and carriage 88, the tracking error which is the difference of the truck location which sways with the eccentricity of a medium, and the location of a light beam is detected optically, and tracking error detection equipment 78 outputs it, as shown in drawing 4 . Moreover, the force disturbance 90, such as friction disturbance reversed to the timing of the passing speed zero in the reciprocating motion of the carriage accompanying eccentric disturbance, joins carriage 88.

[0153] About such a feedback control system, if it is in this 2nd operation gestalt, the learning-control

section 104 was formed between the tracking error detecting element 78 and the feedback control section 80, the tracking error signal TES from the tracking error detecting element 78 was inputted into the learning-control section 104, study processing was carried out, study tracking error signal TES^repeat obtained as a study result was added to the tracking error signal TES from the tracking error detecting element 78 in the summation point 106, and it has inputted into the feedback control section 80 as feedback signal TESFB.

[0154] Drawing 18 is the functional block diagram of the learning-control section 104 of drawing 17 , and the fundamental configuration except learning the tracking error signal TES and outputting study tracking error signal TES^repeat as a learning-control signal is the same as the 1st operation gestalt of drawing 5 .

[0155] That is, the learning-control section 104 consists of a control section 92, the sample processing section 94, approximation function operation part 96, ring buffer memory 98, and the FF output section 100, and the cell address operation part which specifies the cel location of the ring buffer memory 98 is prepared in the control section 92. Instead of the feedback current of the periodicity in the 1st operation gestalt shown in drawing 6 , the learning algorithm by the learning-control section 104 of this drawing 18 defines the time function for every period for the tracking error signal TES, and is calculating approximation function TES^repeat (t) as height Ci of each strip of paper which carried out N division similarly.

[0156] For this reason, if it is in the 2nd operation gestalt, it is the period tangent line of medium 1 revolution. The approximation function approximated in the height of the strip of paper which carried out N division becomes like a degree type.

TES^repeat(t)=Ci (7)

However, i=floor (t/T)

The height Ci of T=tangent line / N0 <=t<tangent line, and a strip of paper is computed by the degree type.

[0157]

[Equation 13]

$$Ci = Klearn \cdot TES\ repeat\ (t) \qquad (8)$$

[0158] However, i=floor (t/T)

T=tangent line / N0 <=t<tangent line -- with actual equipment, multiple times are sampled between the time intervals T of a strip of paper, and if a sampling period is set to Tsample, the storage value over the memory cell of the ring buffer memory 98 of drawing 18 will be calculated by the degree type.

mem[i] = mem[i]+Klearn and Tsample-TES (t) (9)

However, i=floor (t/T)

The address arithmetic for memorizing T=tangent line / N0 <=t<tangent line study result to the memory cell to which the ring buffer memory 98 is equivalent follows (4) types like the case of the 1st example. moreover -- FF -- an output -- the section -- 100 -- depending -- the result of an operation -- an output -- the time -- a cell address -- the -- one -- operation -- a gestalt -- the same -- a feedback control system -- a time delay -- having taken into consideration -- control -- time amount -- delta -- tlead -- depending -- (-- six --) -- a formula -- following .

[0159] study tracking error signal TES^repeat to which drawing 19 is the signal wave form of each part in the learning mode in the 2nd operation gestalt which learns drawing 17 and the tracking error signal TES of drawing 18 , and the tracking error signal TES and drawing 19 (B) are outputted for drawing 19 (A) as a study result, feedback signal TESFB from which drawing 19 (C) serves as an input of the feedback control section 80, and drawing 19 (D) -- carriage actuation current IVCM it is .

[0160] This drawing 19 (A) Although the tracking error by eccentric disturbance and the peak friction disturbance accompanying the carriage passing speed 0 is contained in the tracking error signal TES of drawing 19 (A) if study is started at time of day t0 and it is immediately after study initiation even if it is in - (D) With progress of study, a disturbance component is moved to study tracking error signal TES^repeat of drawing 19 (B), and the disturbance component of the tracking error signal TES is fully

oppressed by study termination.
[0161] Drawing 20 (A) - (D) expands and expresses the wave near [used as time-of-day 0.01-0.05sec of drawing 19] study initiation with the time-axis. That is, study is started at time of day t0, and if it is immediately after study initiation, the peak friction disturbance produced to eccentric disturbance and carriage passing speed 0 timing is included in the tracking error signal TES of drawing 21 (A).
[0162] Moreover, in case a study result is read from the ring buffer memory 98 in FF output section 100 of drawing 18 , lead compensation by the set of progress time amount deltatlead which performs delay compensation of a feedback control system is performed.
[0163] Drawing 21 has expanded the wave of each part in the middle of study of drawing 19 of time-of-day 0.1-0.14sec on the time-axis. Furthermore, drawing 22 has expanded the wave of each part near [used as time-of-day 0.2-0.25sec of drawing 19] study termination on the time-axis. the disturbance component contained in the tracking error signal TES of drawing 22 (A) if it is in the wave near [this] study termination -- the -- almost -- all -- study tracking error detecting-signal TES^repeat as a study result of drawing 22 (B) The controlled environment to which it is moved, consequently the disturbance by medium eccentricity does not exist in a feedback control system is made.
[0164] Drawing 23 (A) shows the principle of the approximation of an unknown function. Moreover, configuration principle drawing of the control system by this invention is shown in drawing 23 (B), and it is equipped with a summation point 76, the feedback control section 80, the learning-control section 82, a summation point 84, and the single-drive mold tracking device 110.
[0165] strange VCM actuation current signal Irepeat (t) with which that the thick wire in drawing 23 (A) shows can oppress the periodicity disturbance which synchronized with the disk revolution it is . The time of day t used in formula (10) - (12) of in this drawing and the following shows the time of day which synchronized with the disk revolution, and is reset by zero at a certain specific time of day in each disk revolution period. That is, tangent line When it is a disk revolution period, it is 0 <=t<tangent line. It becomes.
[0166] Now, unknown function Irepeat (t) Approximation function I^repeat (t) It considers expressing using the group of the height of the strip-of-paper function of N individual.
I^repeat(t) =Ci (10)
However, it is i=floor (t/T) and T shows the time amount width of face of each strip-of-paper function (that is, it is T=tangent line/N and i becomes the integer of 0 <=i<N -1). floor (x) is smaller than x, or is a function which returns the integer nearest to x [equal to x] here.
[0167] Height Ci of each strip-of-paper function Output IFB of the feedback control section 80 (t) It uses as a study input and is updated by real time by the following simple study rule as shown in (11).
[0168]
[Equation 14]

$$\dot{c}_i = \begin{cases} k \cdot I_{FB}(t) & if \quad iT \le t < (i+1)T \\ 0 & otherwise \end{cases} \qquad (11)$$

[0169] However, k is study gain. This study rule is IFB (t). It has the work which changes the height of each strip-of-paper function in the direction which becomes zero.
[0170] The learning-control section 82 is the feedforward signal IFF (t) simultaneously. It outputs as follows.
[0171]
[Equation 15]

$$I_{FF}(t) = \begin{cases} \hat{I}_{repeat}(t + \Delta t_{lead}) & if\ 0 \le t < (T_L - \Delta t_{lead}) \\ \hat{I}_{repeat}(t + \Delta t_{lead} - T_L) & if\ (T_L - \Delta t_{lead}) \le t < T_L \end{cases} \qquad (12)$$

[0172] However, deltatlead is the progress time amount for stabilizing convergence of study.
[0173] The following expressions which expressed the definition of a strip-of-paper function more

clearly are sufficient as the principle of the above invention.
[0174] Drawing 23 (A) shows the principle of the approximation of an unknown function. Moreover, configuration principle drawing of the control system by this invention is shown in drawing 23 (B), and it is equipped with a summation point 76, the feedback control section 80, the learning-control section 82, a summation point 84, and the single-drive mold tracking device 110. strange VCM actuation current signal Irepeat (t) with which that the thick wire in drawing 23 (A) shows can oppress the periodicity disturbance which synchronized with the disk revolution it is .
[0175] The time of day t used in formula (13) - (16) of in this drawing and the following shows the time of day which synchronized with the disk revolution, and is reset by zero at a certain specific time of day in each disk revolution period. That is, tangent line When it is the revolution period of a disk, it is 0 <=t<tangent line. It becomes.
[0176] Now, unknown Irepeat (t) Approximation function I^repeat (t) It considers expressing using total of the strip-of-paper function of N individual like a degree type.
[0177]
[Equation 16]

$$\hat{I}_{repeat}(t) = \sum_{i=0}^{N-1} c_i \cdot \Pi_i(t) \qquad (13)$$

 [0178] However, pii (t) It is the strip-of-paper function shown by (14) formulas.
[0179]
[Equation 17]

$$\Pi_i(t) = \begin{cases} 1 & if\ iT \le t < (i+1)T \\ 0 & else \end{cases} \qquad (14)$$

[0180] Here, T shows the time amount width of face of each strip-of-paper function (that is, it is T=tangent line/N and i is the integer of 0 <=i<N -1.).
[0181] Height Ci of each strip-of-paper function Output IFB of the feedback control section 80 (t) It uses as a study input and is updated by real time by simple study rule like the following (15) types.
[0182]
[Equation 18]

$$c_i = k \cdot \Pi_i(t) \cdot I_{FB}(t) \qquad (15)$$

[0183] However, k is study gain. This study rule is IFB (t). It has the work which changes the height of each strip-of-paper function in the direction which becomes zero.
[0184] The learning-control section 82 is the feedforward signal IFF (t) simultaneously. It outputs as follows.
[0185]
[Equation 19]

$$I_{FF}(t) = \begin{cases} \hat{I}_{repeat}(t + \Delta t_{lead}) & if\ 0 \le t < (T_L - \Delta t_{lead}) \\ \hat{I}_{repeat}(t + \Delta t_{lead} - T_L) & if\ (T_L - \Delta t_{lead}) \le t < T_L \end{cases} \qquad (16)$$

[0186] However, deltatlead is the progress time amount for stabilizing convergence of study.
[0187] As mentioned above, two explanation is the differences in a formula expression, and the substantial (it is engineering) semantic content is equivalent. For example, (13) and (14) type expresses (10) types more clearly, and (15) types show ****** equivalent to (11) types.
[0188] In addition, although the above-mentioned operation gestalt took optical storage equipment for the example, it contains magnetic storage and the equipment of other proper storage methods. Moreover, this invention is not limited to the above-mentioned operation gestalt, but includes the proper deformation which does not spoil the object and advantage. Moreover, the definition by the numeric

value of the above-mentioned operation gestalt does not receive this invention.
[0189]
[Effect of the Invention] As explained above, according to this invention, both coarse seeking control of positioning accuracy and tracking control with high positioning accuracy are attached to the feedback control system of the head device performed by migration of the same carriage. The learning-control signal which oppresses a disturbance component by the learning control of a feedback control signal or a tracking error signal is acquired. With the feedforward output to the feedback control system of the study result obtained by learning control, without extending the band of a feedback control system An eccentric location gap, the location gap by peak friction disturbance, etc. can be oppressed effectively, and the control precision and responsibility of a feedback control system in seeking control and tracking control can be improved substantially.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The principle explanatory view of this invention
[Drawing 2] The block diagram of the optical disk drive with which this invention is applied
[Drawing 3] The explanatory view of the internal structure of the optical disk drive of drawing 2
[Drawing 4] The block diagram of the 1st operation gestalt of this invention which prepared the learning-control section between the feedback control section and an actuator
[Drawing 5] The functional block diagram of the learning-control section of drawing 4
[Drawing 6] The explanatory view of serial study to the periodic control input by the learning-control section of drawing 4
[Drawing 7] The explanatory view of the memory of drawing 5
[Drawing 8] The flow chart of control processing of the 1st operation gestalt of drawing 4
[Drawing 9] The flow chart of the learning-control section of drawing 8
[Drawing 10] The flow chart of feedforward output processing of drawing 8
[Drawing 11] The wave form chart of the tracking error signal from the study initiation by the 1st operation gestalt of drawing 5 to termination, a feedback control signal, a learning-control signal, and a driving signal
[Drawing 12] The wave form chart which expanded the study initiation part of drawing 11 on the time-axis
[Drawing 13] The wave form chart which expanded the part on the time-axis in the middle of study of drawing 11
[Drawing 14] The wave form chart which expanded the study termination part of drawing 11 on the time-axis
[Drawing 15] The wave form chart of the tracking error signal from the study initiation at the time of not performing lead compensation with the 1st operation gestalt of drawing 5 to termination, a learning-control signal, and a driving signal
[Drawing 16] The wave form chart which expanded the study termination part of drawing 15 on the time-axis
[Drawing 17] The block diagram of the 2nd operation gestalt of this invention which prepared the learning-control section between a tracking error detecting element and the feedback control section
[Drawing 18] The functional block diagram of the learning-control section of drawing 17
[Drawing 19] The wave form chart of the tracking error signal from the study initiation by the 2nd operation gestalt of drawing 17 to termination, a tracking error study signal, the sum signal of a tracking error signal and a tracking error study signal, a learning-control signal, and a driving signal
[Drawing 20] The wave form chart which expanded the study initiation part of drawing 19 on the time-axis
[Drawing 21] The wave form chart which expanded the part on the time-axis in the middle of study of drawing 19
[Drawing 22] The wave form chart which expanded the study termination part of drawing 19 on the

time-axis
[Drawing 23] The explanatory view of the principle of the approximation of an unknown function, and the configuration principle of the control system by this invention
[Drawing 24] Property drawing of fixed friction to the passing speed in the head device of a single-drive mold
[Drawing 25] The explanatory view of the eccentric following error according the periodicity disturbance by fixed friction to the feedback control system at the time of a carrier beam
[Description of Notations]
10: Control board
11: Enclosure
12:MPU
14: An optical disk controller
16:DSP
18: Buffer memory
20: Light LSI circuit
24: Lead LSI circuit
30: Laser diode unit
32: ID / detector for MO
40: Spindle motor
44: Magnetic field impression section
45: The detector for FES
46: FES detector
47: The detector for TES
48: TES detector
50: TZC detector
52: A focal actuator
54: VCM (voice coil motor)
64: MO cartridge
66: MO medium
68: Carriage
70: Objective lens
72: Fixed optical system
76: Tracking error detecting element (position signal detecting element)
78 84,105: Adder unit
80: Feedback operation part
82,104: Learning-control section
86: Actuator (VCM)
88: Carriage
90: Force disturbance
92: Control section
94: Sample processing section
96: Approximation function operation part
98: Memory
100: Feedforward output section (FF output section)
106-1 - 106-N: Memory cell
110: Single-drive mold tracking device

[Translation done.]

* NOTICES *

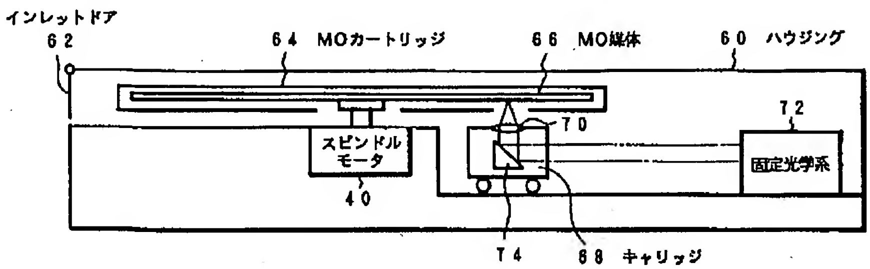
JPO and NCIPI are not responsible for any damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

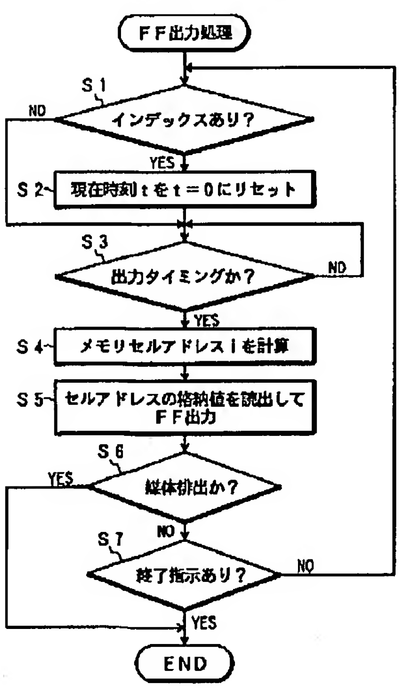
DRAWINGS

[Drawing 3]

図2の光ディスクドライブの内部構造の説明図

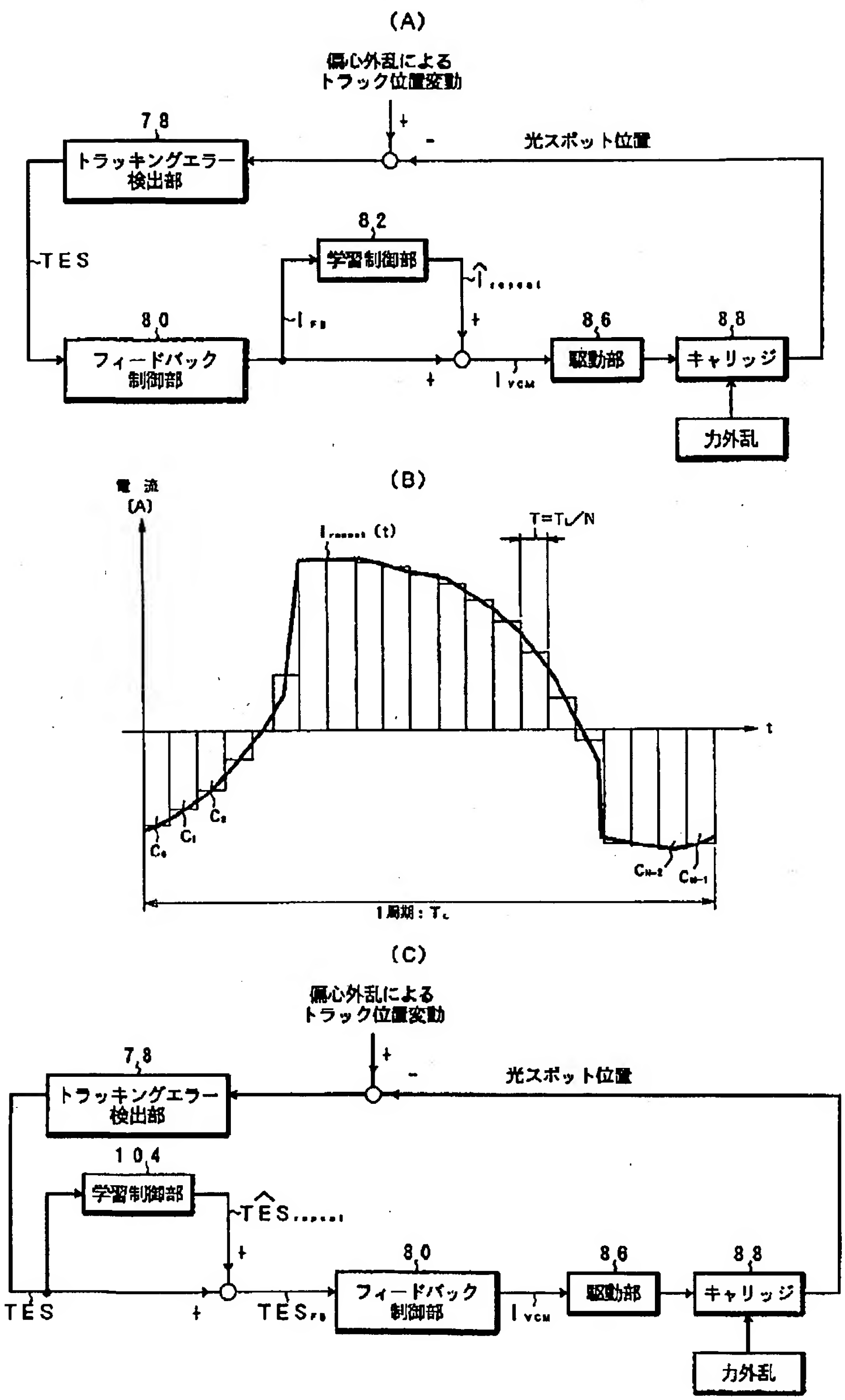


[Drawing 10]
図8のフィードフォワード出力処理のフローチャート



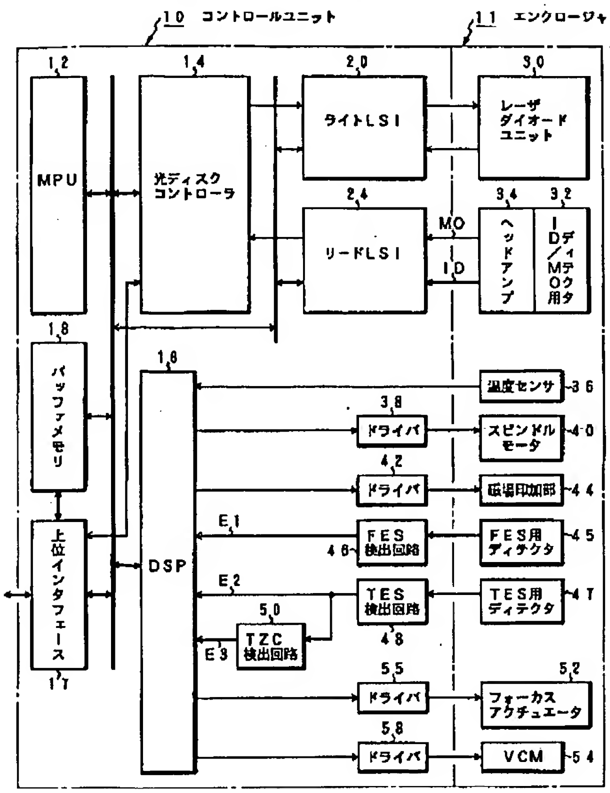
[Drawing 1]

本発明の原理説明図



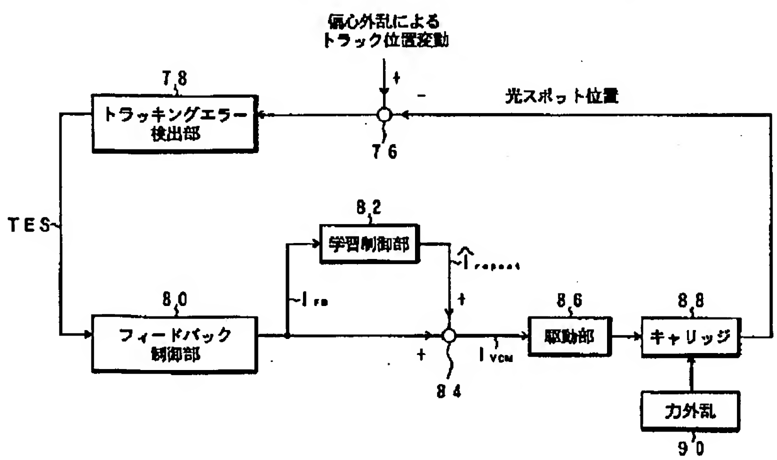
[Drawing 2]

本発明が適用される光ディスクドライブのブロック図



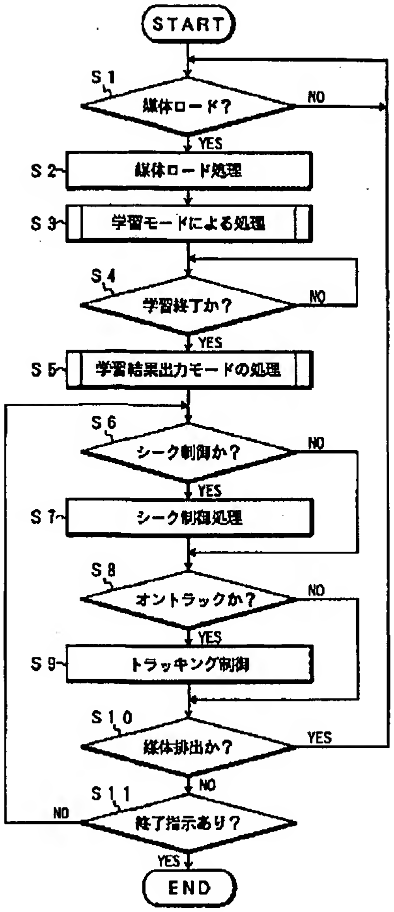
[Drawing 4]

フィードバック制御部と駆動部との間に学習制御部を設けた本発明の第1実施形態のブロック図



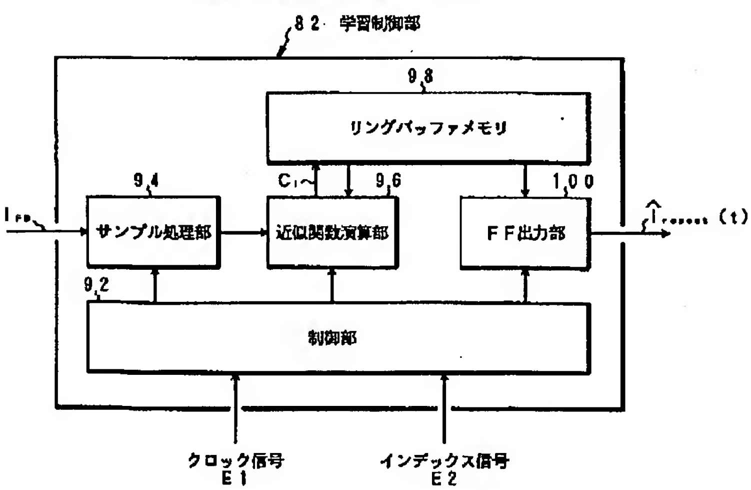
[Drawing 8]

図４の第１実施形態の制御処理のフローチャート



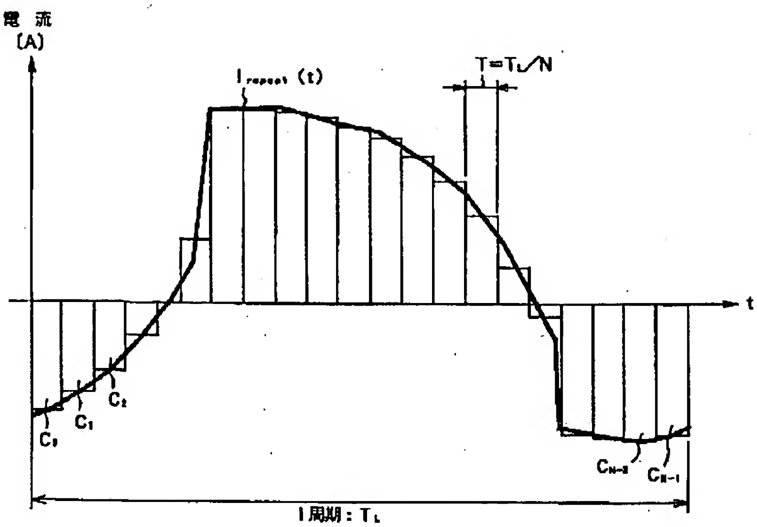
[Drawing 5]

図４の学習制御部の機能ブロック図



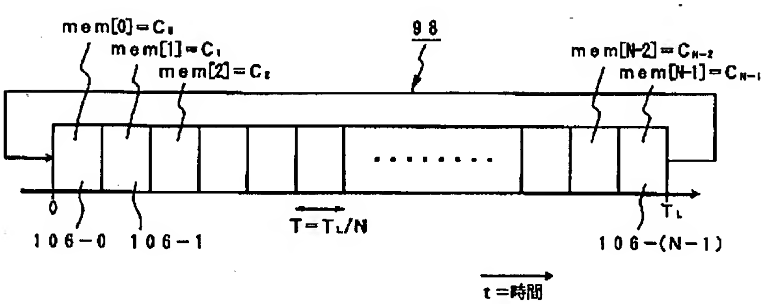
[Drawing 6]

図4の学習制御部による周期的な制御入力に対する逐次学習の説明図



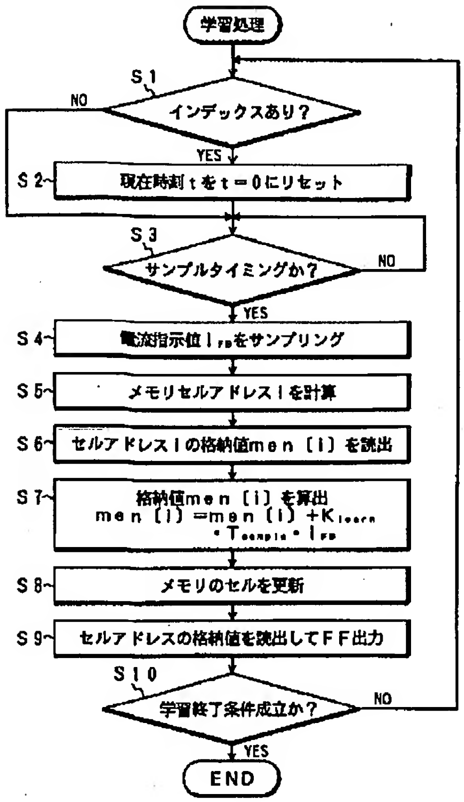
[Drawing 7]

図5のメモリの説明図



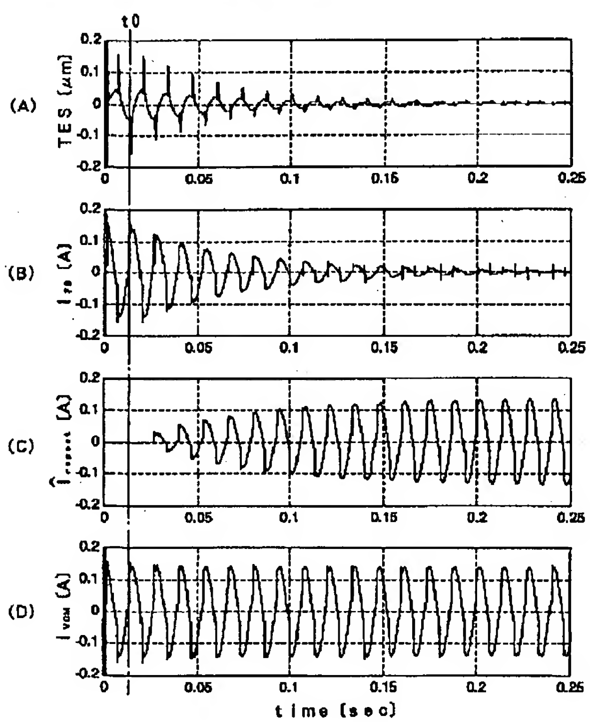
[Drawing 9]

図8の学習処理のフローチャート



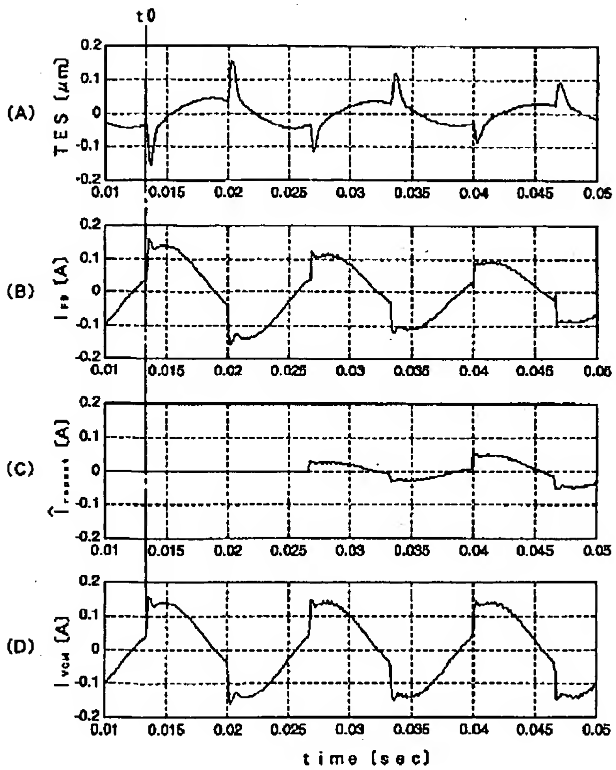
[Drawing 11]

図5の第1実施形態による学習開始から終了までのトラッキングエラー信号、フィードバック制御信号、学習制御信号及び駆動信号の波形図



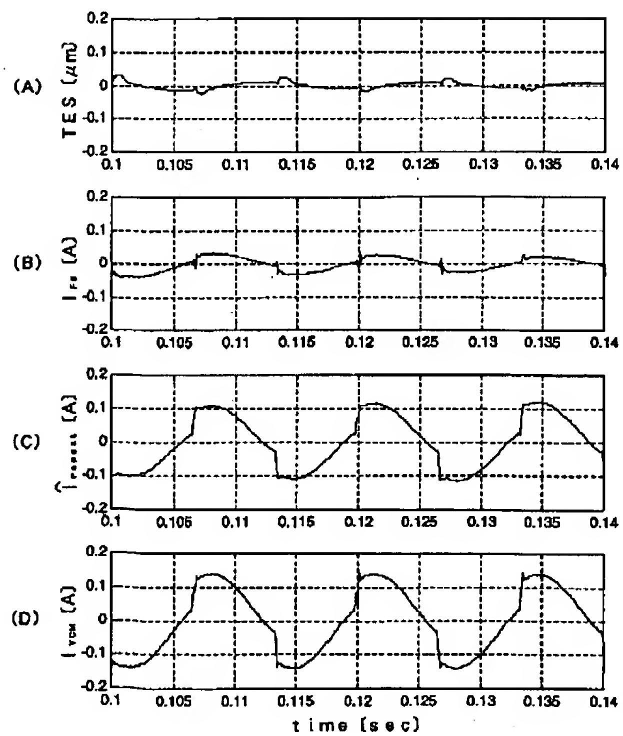
[Drawing 12]

図１１の学習開始部分を時間軸で拡大した波形図



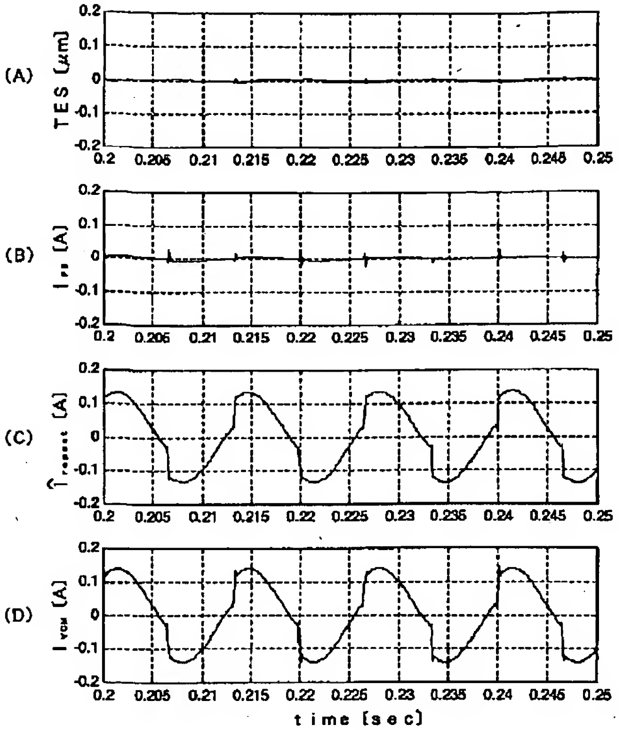
[Drawing 13]

図１１の学習途中部分を時間軸で拡大した波形図



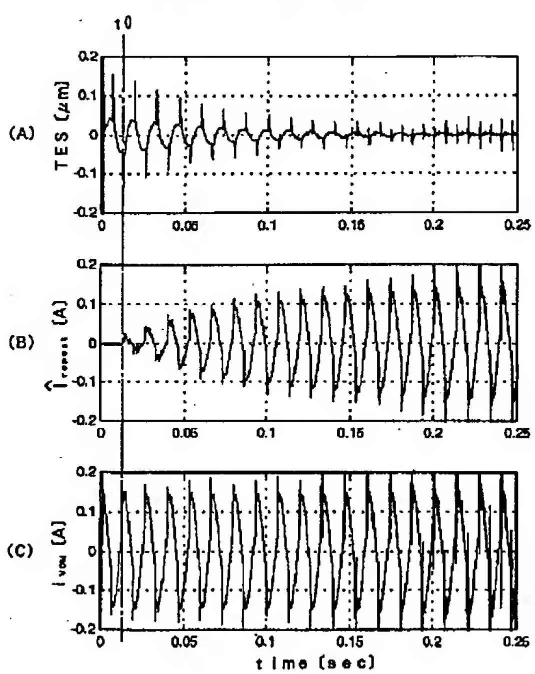
[Drawing 14]

図11の学習終了部分を時間軸で拡大した波形図



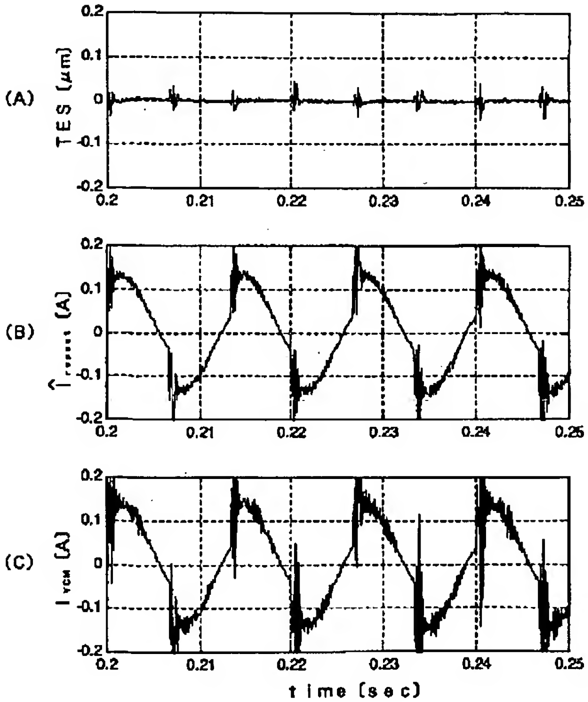
[Drawing 15]

図5の第1実施形態で進み補償を行わなかった場合の学習開始から終了までのトラッキングエラー信号、学習制御信号及び駆動信号の波形図



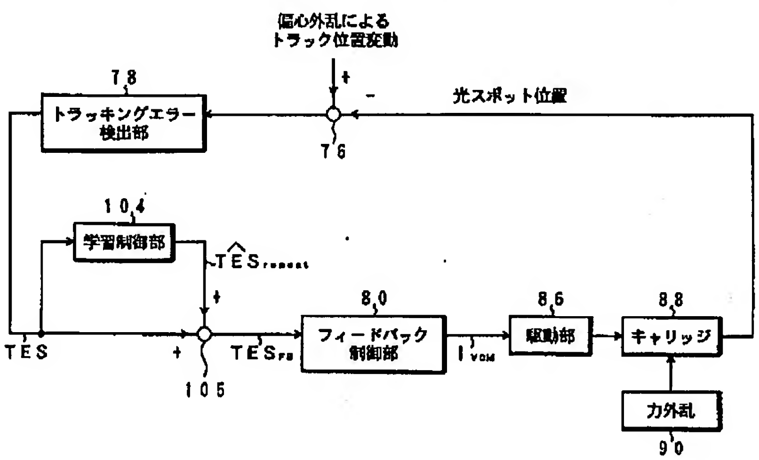
[Drawing 16]

図１５の学習終了部分を時間軸で拡大した波形図



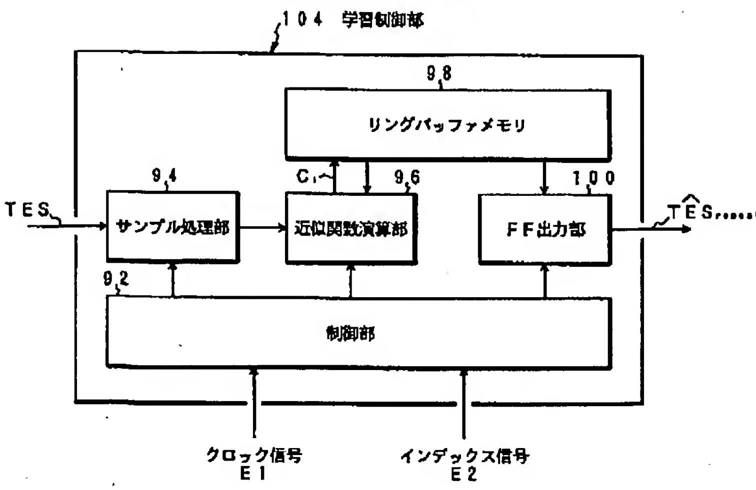
[Drawing 17]

トラッキングエラー検出部とフィードバック制御部との間に学習制御部を設けた本発明の第２実施形態のブロック図



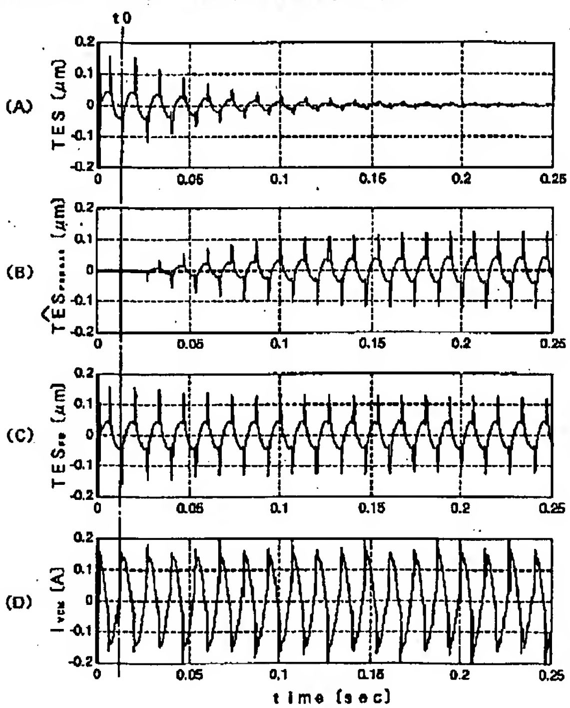
[Drawing 18]

図１７の学習制御部の機能ブロック図



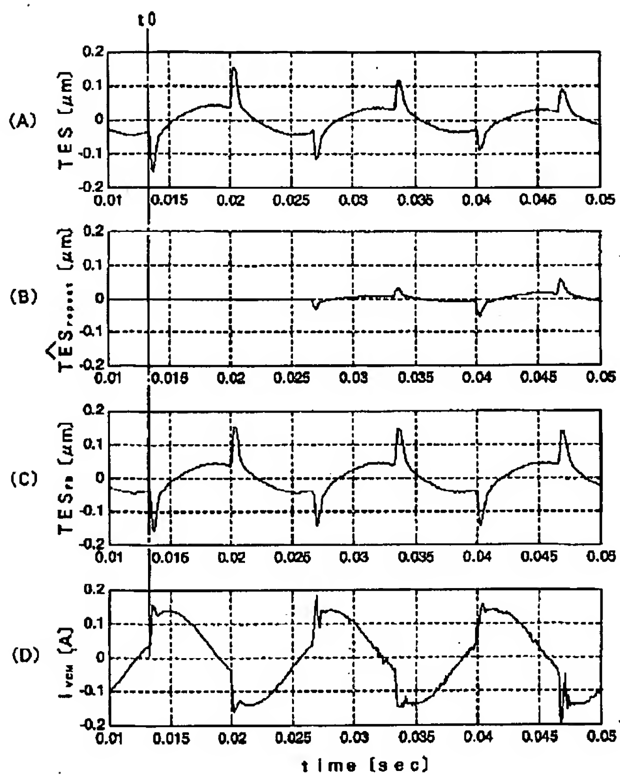
[Drawing 19]

図１７の第２実施形態による学習開始から終了までのトラッキングエラー信号、トラッキングエラー学習信号、トラッキングエラー信号とトラッキングエラー学習信号の和信号、学習制御信号及び駆動信号の波形図



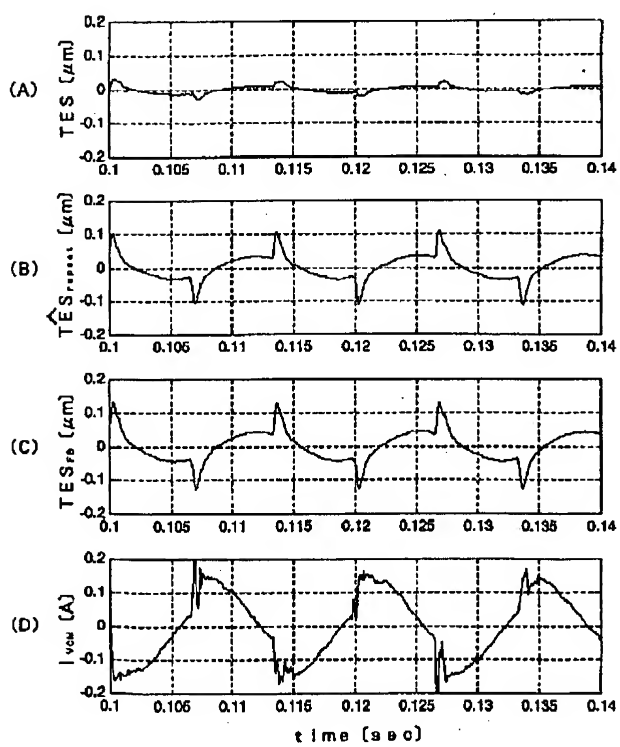
[Drawing 20]

図１９の学習開始部分を時間軸で拡大した波形図



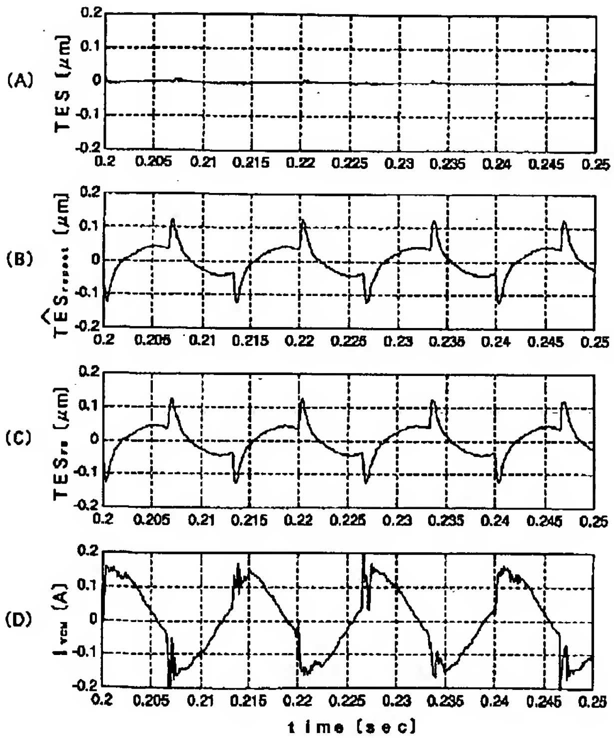
[Drawing 21]

図１９の学習途中部分を時間軸で拡大した波形図



[Drawing 22]

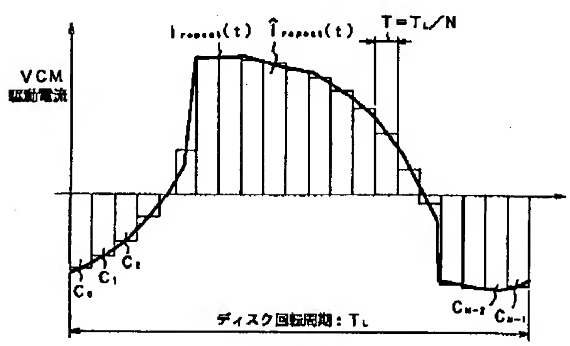
図１９の学習終了部分を時間軸で拡大した波形図



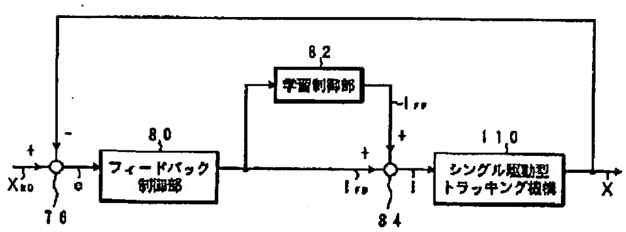
[Drawing 23]

未知関数の近似法の原理と本発明による制御系統の構成原理の説明図

(A)



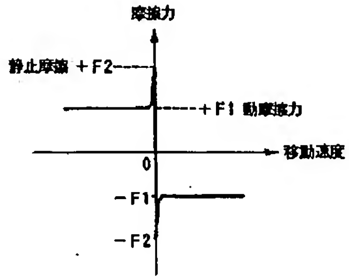
(B)



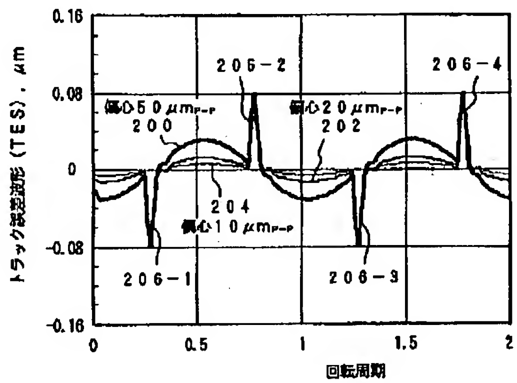
X_{RO} : 媒体偏心によるトラックの変位
X : キャリッジ変位
e : トラッキングエラー (TES)
I_{FB} : フィードバックコントローラ出力
I_{FF} : フィードフォワード信号 (学習制御系出力)
I : キャリッジ駆動信号 (VCM駆動信号)

[Drawing 24]

シングル駆動型のヘッド機構における移動速度に対する固定摩擦の特性図



[Drawing 25]
固定摩擦による周期性外乱を受けた時のフィードバック制御系による偏心追従誤差の説明図



[Translation done.]